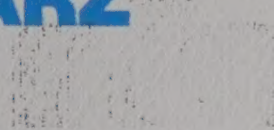




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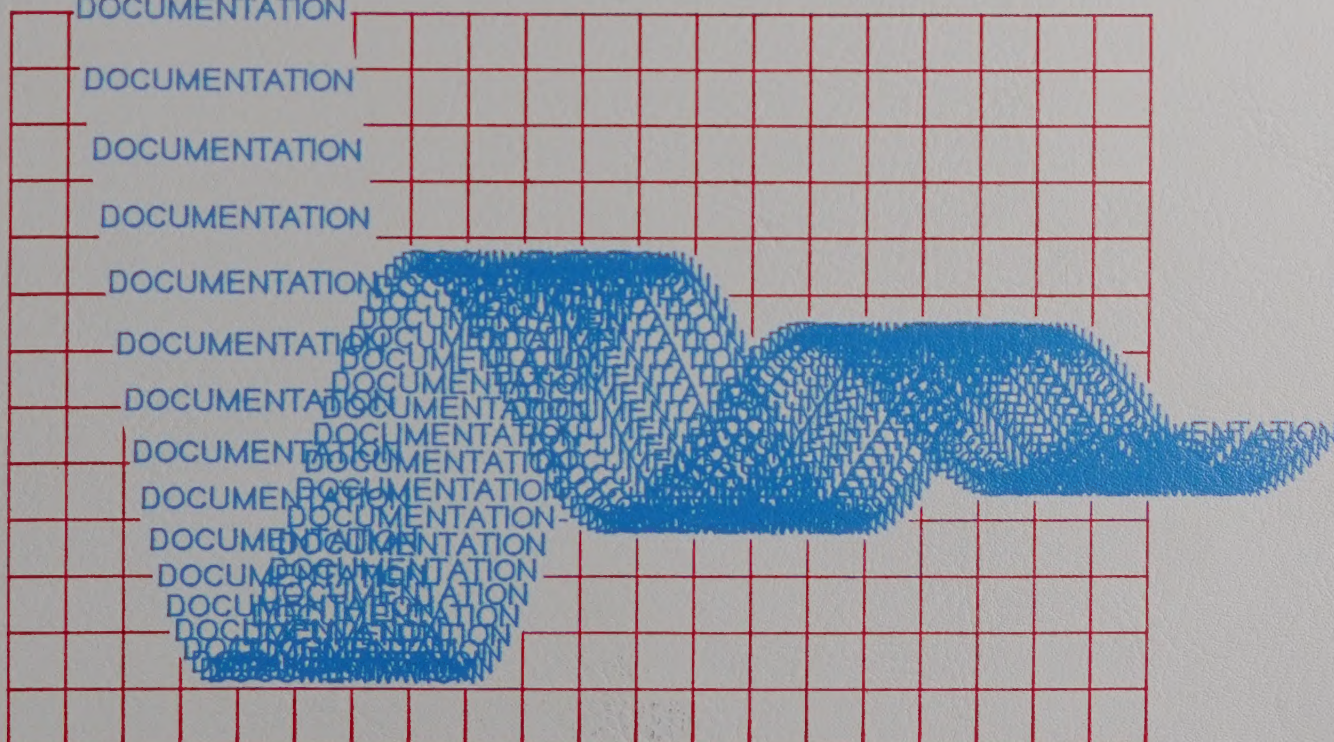
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Power Sensors **NRV-Z**

for RF and microwave power measurements

DC to 26.5 GHz

400 pW to 0.5 W



The right sensor for every application

Power Sensors **NRV-Z**

for RF and microwave power measurements



With its large variety of power sensors Rohde & Schwarz is able to provide the right tools for all power measurements using a power meter from the NRV family.

Ten power sensors in all cover the frequency range from DC to 26.5 GHz. Three classes of sensitivity enable direct measurement of any level between 400 pW and 500 mW. Higher powers up into the kW range can be measured when connecting directional couplers or power attenuators to the input of the sensor. A 75- Ω sensor is available for TV and video applications.

Plug-in and go

Using the calibrated power sensors of the NRV family for high-precision measurements has the great advantage that no time is wasted for calibration. The built-in calibration data memory contains all the relevant information and relieves the user from error-prone and time-consuming work. There is no need for regular recalibration of the power meter following a temperature change or change of the power sensor nor is it necessary to read

and enter correction factors. With a power sensor plugged in, a fully calibrated power meter is immediately ready for measurements. In addition to the data required for measurements, the calibration data memory also contains information simplifying the operation: instead of having to deal with code numbers which may mean 100 nW in one case and 1 mW in the other, the users of NRVD and NRVS can select all measurement ranges in plain text.

Interior view of Thermocouple Power Sensor NRV-Z51: precision in semiconductor and thin-film technology



DC to 26.5 GHz
400 pW to 0.5 W

The right sensor for every application

Power sensors absorb the RF power applied and provide at their output an equivalent DC voltage. To cover the complete power range from less than 1 nW to more than 100 mW, two different types of power sensors are required: thermocouple sensors based on the Seebeck effect and semiconductor detectors using zero-bias Schottky diodes of ultramodern technology. Both types of transducers are available for the entire frequency spectrum.

Thermocouple sensors like the NRV-Z51 cover the power range from 1 μ W to 100 mW. Irrespective of the waveform, they always indicate the RMS power. Being individually calibrated, the Rohde & Schwarz thermocouple power sensors feature an unrivalled linearity over the entire dynamic range.

High-sensitivity sensors based on diode detectors like the NRV-Z4 are indispensable

0.4 nW to 10 μ W. These sensors also measure the true RMS power in the specified range and can be easily used for signals with harmonic contents, noisy or modulated signals.

Medium-sensitivity sensors based on diode detectors with 20-dB input attenuators like the NRV-Z5 close the gap between the high-sensitivity and the thermocouple sensors. Due to their excellent matching and short measurement times they are ideal sensors for true RMS power measurements in the range from 1 μ W to 1 mW.



Calibration of NRV power sensors is directly traceable to the Federal German Bureau of Standards

With signals of relatively high spectral purity, the diode power sensors can be used far beyond the RMS range: the high-sensitivity sensors up to about 20 mW and the medium-sensitivity sensors up to 0.5 W. The extremely large dynamic range makes these sensors highly suitable for reflection and attenuation measurements. The fast measurement rate at higher power ratings is an advantage in system applications.

Precision calibration

Each NRV power sensor has all the measurement-relevant information in its built-in data memory. The correlation between the measu-

red power and the sensor output signal is established via frequency-dependent calibration factors. These calibration factors can only be precisely determined with the aid of special measuring instruments. To enhance the measurement accuracy, the standards used are directly linked to the primary standards of the Federal German Bureau of Standards.

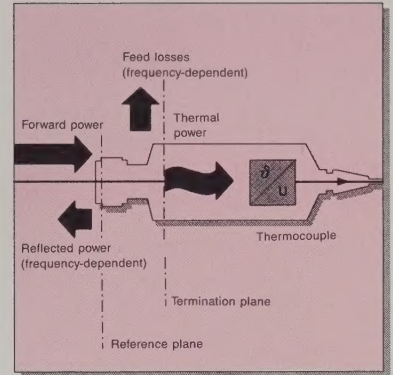
However, measurement errors do arise in the determination of the calibration factors. The individual error components are summed statistically and specified in the technical data as RSS calibration uncertainty with a confidence level of about 95%.

The calibration factors are defined so that all power sensors provide reading of the forward power, i.e. the power applied to the sensor. They take into account power losses caused by reflections as well as the loss of RF power between the connector and the sensor (see diagram).

After the test frequency has been entered, all power meters of the NRV family automatically scan the data memory for the relevant calibration factor to correct the indicated power.

Excellent matching

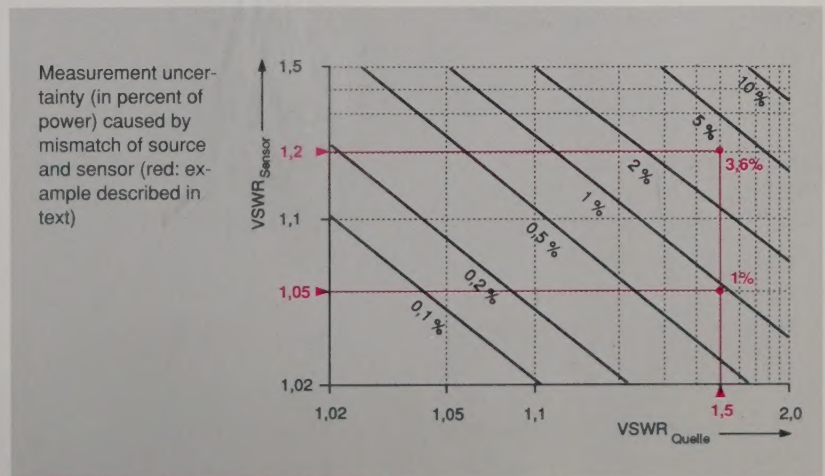
The NRV-Z power sensors feature excellent matching. Low SWR throughout the frequency range makes for relatively small matching errors. Mismatch, however, still is the main uncertainty factor in power measurements.



Power meters are calibrated to forward power reading; diagram showing power flow of thermocouple power sensor

Sources with poor matching, in particular, do not supply the rated power to the sensor, but significantly higher or lower values, depending on the reflected power. The more the sensor is matched, the less is the effect of reflections. The measurement error limits are shown in the diagram below.

Example: power measurement on a source with a SWR of 1.5. A well-matched sensor with a SWR of 1.05 causes a mismatch uncertainty of as little as 1% while a badly matched sensor (SWR = 1.2) will produce an uncertainty of 3.6% (red curve).



Power meters

Six power meters are available for power measurements using the NRV sensors.

NRVD Modern dual-channel power meter with menu operation and high-speed IEC/IEEE-bus connector (SCPI). Ideal for relative measurements in two test channels (attenuation, reflection). Large variety of measurement functions, result display in all standard units. Many extras like 1-mW test generator, indication of measurement uncertainty, etc. All power sensors suitable.

NRVS Attractively priced, single-channel power meter, same operation as NRVD. Many measurement functions, result display in all standard units, analog output fitted as standard. IEC/IEEE-bus connector, syntax-compatible with NRV/URV 5. All power sensors suitable.

NRV Well-proven dual-channel power meter for use in labs and systems. Many measurement functions, result display in all standard units, IEC/IEEE-bus connector. All power sensors, except for NRV-Z51/Z52, suitable.

URV 35 Compact voltmeter and power meter for use in service, testshops and labs. Unique combination of analog and digital display in form of moving-coil meter plus LCD. Many measurement functions, display in all standard units, choice of battery or AC supply operation, RS-232 interface. All power sensors suitable.

URV 55 Attractively priced, single-channel voltmeter, similar to NRVS. All power sensors suitable.

URV 5 Dual-channel voltmeter, similar to NRV. All power sensors, except for NRV-Z51/Z52, suitable.

Measuring heads for voltage and level measurement

Probes and insertion units (data sheet PD 756.9816) further enhance the application range of the NRV power meter family:

RF Probe URV 5-Z7

For virtually no-load measurements in RF circuits up to 400 MHz. Comprehensive accessories, including adapters for 50- Ω and 75- Ω connectors.

DC Probe URV 5-Z1

For low-load DC measurements in RF circuits from 1 mV to 400 V.

Insertion Units URV 5-Z2/Z4

For level measurement between source and load in coaxial 50- Ω and 75- Ω systems. With an optimally matched load, power measurements from -60 to +53 dBm are even possible without directional coupler. Frequency range 9 kHz to 2 GHz.

Dual Directional Coupler URV 5-Z9

For directional power and reflection measurements in conjunction with two RF Probes URV 5-Z7. Frequency range 100 kHz to 80 MHz, power measurement range 10 μ W to 2 kW.



Specifications

High-sensitivity sensors

RMS weighting up to 10 μ W

Model	Frequency range	Power range Max. power	SWR (reflection coefficient)	Zero error ($\pm$) ¹⁾	Meter noise 2 σ ²⁾	Linearity error ($\pm$) ³⁾	Connector
NRV-Z4	100 kHz to 6 GHz	500 pW to 20 mW 100 mW (avg) 100 mW (pk)	0.1 to 100 MHz: 1.05 (0.024) 0.1 to 2 GHz: 1.1 (0.048) 2 to 4 GHz: 1.2 (0.09) 4 to 6 GHz: 1.35 (0.15)	50 pW	20 pW	0.4 %	N
NRV-Z7	10 MHz to 13 GHz	1 nW to 20 mW 100 mW (avg) 100 mW (pk)	0.01 to 1 GHz: 1.06 (0.03) 1 to 2 GHz: 1.13 (0.06) 2 to 4 GHz: 1.27 (0.12) 4 to 13 GHz: 1.41 (0.17)	100 pW	40 pW	0.4 %	N
NRV-Z1	10 MHz to 18 GHz	1 nW to 20 mW 100 mW (avg) 100 mW (pk)	0.01 to 1 GHz: 1.06 (0.03) 1 to 2 GHz: 1.13 (0.06) 2 to 4 GHz: 1.27 (0.12) 4 to 18 GHz: 1.41 (0.17)	100 pW	40 pW	0.4 %	N
NRV-Z6	50 MHz to 26.5 GHz	1 nW to 20 mW 100 mW (avg) 100 mW (pk)	0.05 to 0.1 GHz: 1.3 (0.13) 0.1 to 18 GHz: 1.2 (0.09) 18 to 26.5 GHz: 1.4 (0.165)	200 pW	80 pW	0.5 %	PC 3.5
NRV-Z3 75 Ω	1 MHz to 2.5 GHz	400 pW to 13 mW 70 mW (avg) 70 mW (pk)	0.001 to 1 GHz: 1.11 (0.05) 1 to 2.5 GHz: 1.2 (0.09)	40 pW	16 pW	0.4 %	N

Medium-sensitivity sensors

RMS weighting up to 1 mW

Model	Frequency range	Power range Max. power	SWR (reflection coefficient)	Zero error ($\pm$) ¹⁾	Meter noise 2 σ ²⁾	Linearity error ($\pm$) ³⁾	Connector
NRV-Z5	100 kHz to 6 GHz	50 nW to 500 mW 2 W (avg) 10 W (pk)	100 kHz to 4 GHz: 1.05 (0.024) 4 to 6 GHz: 1.1 (0.048)	5 nW	2 nW	0.3 %	N
NRV-Z8	10 MHz to 13 GHz	100 nW to 500 mW 2 W (avg) 10 W (pk)	0.01 to 4 GHz: 1.05 (0.024) 4 to 8 GHz: 1.1 (0.048) 8 to 13 GHz: 1.15 (0.07)	10 nW	4 nW	0.3 %	N
NRV-Z2	10 MHz to 18 GHz	100 nW to 500 mW 2 W (avg) 10 W (pk)	0.01 to 4 GHz: 1.05 (0.024) 4 to 8 GHz: 1.1 (0.048) 8 to 12.4 GHz: 1.15 (0.07) 12.4 to 18 GHz: 1.2 (0.09)	10 nW	4 nW	0.3 %	N

Thermocouple sensors

RMS weighting in complete measurement range

Model	Frequency range	Power range Max. power	SWR (reflection coefficient)	Zero error ($\pm$) ¹⁾	Meter noise 2 σ ²⁾	Linearity error ($\pm$) ³⁾	Connector
NRV-Z51	DC to 18 GHz	1 μ W to 100 mW 300 mW (avg) 10 W (pk, 1 μ s)	DC to 2 GHz: 1.1 (0.048) 2 to 12.4 GHz: 1.15 (0.07) 12.4 to 18 GHz: 1.2 (0.09)	60 nW	22 nW	0.6 %	N
NRV-Z52	DC to 26.5 GHz	1 μ W to 100 mW 300 mW (avg) 10 W (pk, 1 μ s)	DC to 2 GHz: 1.1 (0.048) 2 to 12.4 GHz: 1.15 (0.07) 12.4 to 18 GHz: 1.2 (0.09) 18 to 26.5 GHz: 1.25 (0.11)	60 nW	22 nW	0.6 %	PC 3.5

Calibration uncertainties

RSS in %, referred to indicated power

Frequency (MHz)	NRV-Z3	NRV-Z4	NRV-Z5
0.1	-	0.8	0.8
0.15	-	0.8	0.8
0.2	-	0.8	0.8
0.455	-	0.8	0.8
1	1.1	0.8	0.8
1.25	1.1	-	-
3	1.1	-	-
10	1.1	0.8	0.8
30	1.1	-	-
50	1.1	0.8	0.8
100	1.1	0.8	0.8
500	1.6	1.5	1.4
1000	1.6	1.5	1.4
1200	2.0	-	-
1400	2.0	-	-
1500	-	1.5	1.4
1600	2.0	-	-
1800	2.0	-	-
2000	2.0	1.5	1.4
2100	2.0	-	-
2200	2.0	-	-
2300	2.0	-	-
2400	2.0	-	-
2500	2.0	1.8	1.7
3000	-	1.8	1.7
3200	-	1.8	1.7
3400	-	1.8	1.7
3600	-	1.8	1.7
3800	-	1.8	1.7
4000	-	1.8	1.7
4200	-	2.2	1.9
4400	-	2.2	1.9
4600	-	2.2	1.9
4800	-	2.2	1.9
5000	-	2.2	1.9
5200	-	2.2	1.9
5400	-	2.2	1.9
5600	-	2.2	1.9
5800	-	2.2	1.9
6000	-	2.2	1.9

Frequency (GHz)	NRV-Z1/Z7 ⁴⁾	NRV-Z2/Z8 ⁴⁾	NRV-Z51	NRV-Z6	NRV-Z52
0.01	1.6	0.8	0.6	-	0.7
0.05	1.6	0.8	0.6	1.3	0.7
0.1	1.6	0.8	0.6	1.3	0.7
0.5	2.1	1.5	0.8	1.3	1.0
1	2.1	1.5	0.8	1.3	1.0
1.5	2.1	1.5	-	-	-
2	2.1	1.5	0.8	1.3	1.0
2.5	2.6	1.8	-	-	-
3	2.6	1.8	1.3	1.8	1.6
3.5	2.6	1.8	-	-	-
4	2.6	1.8	1.3	1.8	1.6
4.4	3.8	2.0	-	-	-
5	3.8	2.0	1.3	1.8	1.6
5.4	3.8	2.0	-	-	-
6	3.8	2.0	1.3	1.8	1.6
6.4	3.8	2.0	-	-	-
7	3.8	2.0	1.3	1.8	1.6
7.4	3.8	2.0	-	-	-
8	3.8	2.0	1.3	1.8	1.6
8.4	4.0	2.8	-	-	-
9	4.0	2.8	1.9	2.9	2.5
9.4	4.0	2.8	-	-	-
10	4.0	2.8	1.9	2.9	2.5
10.4	4.0	2.8	-	-	-
11	4.0	2.8	1.9	2.9	2.5
11.4	4.0	2.8	-	-	-
12	4.0	2.8	1.9	2.9	2.5
12.4	4.0	2.8	1.9	2.9	2.5
13	4.0	2.8	2.5	3.2	3.1
13.5	5.6	3.3	-	-	-
14	5.6	3.3	2.5	3.2	3.1
14.5	5.6	3.3	-	-	-
15	5.6	3.3	2.5	3.2	3.1
15.5	5.6	3.3	-	-	-
16	5.6	3.3	2.5	3.2	3.1
16.5	5.6	3.3	-	-	-
17	5.6	3.3	2.5	3.2	3.1
17.5	5.6	3.3	-	-	-
18	5.6	3.3	2.5	3.2	3.1
19	-	-	-	2.8	2.5
20	-	-	-	2.8	2.5
21	-	-	-	2.8	2.5
22	-	-	-	2.8	2.5
23	-	-	-	2.8	2.5
24	-	-	-	2.8	2.5
25	-	-	-	2.8	2.5
26	-	-	-	2.8	2.5
26.5	-	-	-	2.8	2.5

Temperature effect

In %, referred to indicated power (typical values in parenthesis)

	22 to 24 °C	18 to 28 °C	10 to 40 °C	0 to 50 °C
NRV-Z1 to Z8	0 ⁵⁾	1.0 (0.3)	3.0 (1)	7.0 (2)
NRV-Z51/Z52	0 ⁵⁾	0.4 (0.1)	1.3 (0.4)	2.0 (0.5)

Total uncertainty

To calculate the total uncertainty of the source power available at Z₀, the following components have to be taken into account:

Mismatch uncertainty (see diagram)

Calibration uncertainty

Linearity error at 23 °C

Additional linearity error³⁾ (diode power sensors only, other than RMS range)

Meter noise, zero error, temperature effect

Error of power meter (see NRVS, NRVD, NRV specifications)

General data

Operating temperature range 0 to +50 °C, class 1 to IEC 359 (without condensation)
 Storage temperature range -40 to +70 °C
 Dimensions, weight 120 mm x 37 mm x 31 mm, 0.35 kg
 Length of connecting cable approx. 1.3 m; other lengths on request

Order designations

Power Sensor 20 mW, 50 Ω, 18 GHz NRV-Z1 828.3018.02
 Power Sensor 500 mW, 50 Ω, 18 GHz NRV-Z2 828.3218.02
 Power Sensor 13 mW, 75 Ω, 2.5 GHz NRV-Z3 828.3418.02
 Power Sensor 20 mW, 50 Ω, 6 GHz NRV-Z4 828.3618.02
 Power Sensor 500 mW, 50 Ω, 6 GHz NRV-Z5 828.3818.02
 Power Sensor 20 mW, 50 Ω, 26.5 GHz NRV-Z6 828.5010.02
 Power Sensor 20 mW, 50 Ω, 13 GHz NRV-Z7 828.5210.02
 Power Sensor 500 mW, 50 Ω, 13 GHz NRV-Z8 828.5410.02
 Power Sensor 100 mW, 50 Ω, 18 GHz NRV-Z51 857.9004.02
 Power Sensor 100 mW, 50 Ω, 26.5 GHz NRV-Z52 857.9204.02



1) Within 1 h after zero adjustment, permissible temperature variation 1 °C, after 2 h warmup of power meter.

2) Noise specifications (2 standard deviations) referred to filter 11, temperature 18 to 28 °C. With the most sensitive measurement range selected on NRVS and NRVD, filter 11 is automatically set (autofilter mode, resolution HIGH). The noise values for other filter settings are obtained by multiplication with the factors given in the table below.

Filter No.	NRVS/NRVD	0	1	2	3	4	5	6	7	8	9	10	11	12
	URV5/NRV	F5			F4		F3		F2		F1		F0	
Noise multiplier		51	32	23	16	11.3	8	5.6	4	2.8	2	1.4	1.0	0.7
Measurement time/s	NRV-Z1 to Z8	0.045	0.05	0.06	0.08	0.15	0.27	0.49	0.95	1.85	3.6	7.2	14.5	28.5
	NRV-Z51/Z52	0.115	0.12	0.13	0.15	0.21	0.32	0.52	0.92	1.75	3.4	6.6	13	26

The above measurement times are approximate values for remote-controlled operation. For accurate values please refer to NRVS, NRVD and NRV specifications.

3) Linearity referred to calibration power of 10 μW for high-sensitivity sensors, 1 mW for medium-sensitivity sensors and 1.6 mW for thermocouple sensors. All diode power sensors can be used for sinusoidal unmodulated signals far beyond the RMS range. Larger linearity errors can arise:

a) out of the temperature range 23 ± 2 °C (only relevant to relative measurements; irrelevant to calculation of total uncertainty, since already considered in temperature effect)

b) in the frequency and power ranges specified below (additional linearity error). The values specified must be taken into account in calculating the total uncertainty and in relative measurements.

NRV-Z4	1.5 to 3 GHz: +2 % (0.02 to 2 mW), +4 % (2 to 20 mW) 3 to 6 GHz: +6 % (0.02 to 2 mW), +10 % (2 to 20 mW)	NRV-Z5	1.5 to 3 GHz: +2 % (2 to 200 mW), +3.5 % (0.2 to 0.5 W) 3 to 6 GHz: +6 % (2 to 200 mW), +8 % (0.2 to 0.5 W)
NRV-Z1/Z7	4 to 8 GHz: +2 % (0.02 to 2 mW), +4 % (2 to 20 mW) 8 to 13 GHz: +5 % (0.02 to 2 mW), +10 % (2 to 20 mW) 13 to 18 GHz: +6 % (0.02 to 2 mW), +12 % (2 to 20 mW)	NRV-Z2/Z8	4 to 8 GHz: +2 % (2 to 200 mW), +3.5 % (0.2 to 0.5 W) 8 to 13 GHz: +5 % (2 to 200 mW), +8 % (0.2 to 0.5 W) 13 to 18 GHz: +6 % (2 to 200 mW), +10 % (0.2 to 0.5 W)
NRV-Z6	0.05 to 0.2 GHz: -2.5/+0.5 % (0.02 to 2 mW), -4.5/+1.5 % (2 to 20 mW) 0.2 to 14 GHz: ±0.5 % (0.02 to 2 mW), ±1.5 % (2 to 20 mW) 14 to 26.5 GHz: -0.5/+1.5 % (0.02 to 2 mW), -0.5/+4.5 % (2 to 20 mW)		
NRV-Z3	without additional error		

4) Power Sensors NRV-Z7/Z8 calibrated up to 13 GHz only.

5) Included in calibration uncertainty.



ROHDE & SCHWARZ

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ROHDE & SCHWARZ

Measuring Instruments
and Systems Division

Manual

POWER SENSOR

NRV-Z5

828.3818.02

828.3818.03

Printed in the Federal
Republic of Germany



ROHDE & SCHWARZ
EC Certificate of Conformity



Certificate No.: 9502231

This is to certify that:

Equipment type	Order No.	Designation
NRV-Z1	0828.3018.02/.03	Power Sensor
NRV-Z2	0828.3218.02/.03	"
NRV-Z3	0828.3418.02/.03	"
NRV-Z4	0828.3618.02/.03	"
NRV-Z5	0828.3818.02/.03	"
NRV-Z6	0828.5010.02	"
NRV-Z15	1081.2305.02	"
NRV-Z31	0857.9604.02/.03/.04	Peak Power Sensor
NRV-Z32	1031.6807.04/.05	"
NRV-Z33	1031.6507.03/.04	"
NRV-Z51	0857.9004.02	Thermal Power Sensor
NRV-Z52	0857.9204.02	"
NRV-Z53	0858.0500.02	"
NRV-Z54	0858.0800.02	"
NRV-Z55	1081.2005.02	"

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electromagnetic compatibility
(89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1995

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 26.11.96

Central Quality Management FS-QZ / Becker



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	Components plan	



The Power Sensor NRV-Z5 is used together with the basic unit NRV or with the Millivoltmeter URV5 for power measurements in 50- Ω systems ranging from 50 nW to 500 mW at frequencies from 100 kHz to 6 GHz. Because of its high sensitivity, the sensor may be easily destroyed when handled improperly. Therefore, never exceed the following limits:

Max. permissible power 2 W (CW) / 10 W (PEP)	
AC voltage	10 V

Since the 50- Ω termination is directly connected to the inner conductor, the total power (RF + DC) must not exceed the indicated 2 (10) W limit.

Contrary to other power meters, the probes of which are first to be calibrated with a reference power, the NRV-Z5 is ready for operation immediately after connection. Each sensor is equipped with a memory holding the individual calibration parameters. In the LOCAL mode the basic unit reads out these data automatically as soon as the sensor is connected. In the REMOTE mode, this procedure must be triggered **once** with the IEC-bus command **C0** prior to the first measurement (see also sections 2.3.1, 2.3.2 and 2.4.3 of NRV manuals). In both cases, **init** appears during the readout of calibration parameters.

For detailed description of the sensor, please refer to section 2, **Measurements with the NRV-Z5**. A list of possible error sources in RF power measurements and hints for selecting the appropriate sensor can be found in section 3, **Error Analysis**. Operation of basic unit and the total IEC-bus syntax are described in the NRV (or URV5) manual.

2.1 Measurement Principle

The high-frequency sensor includes two zero-bias-Schottky diodes of latest technology and stable physical characteristics preceded by a 20-dB attenuator. In the power range from 50 nW to 1 mW (0 dBm), this detector behaves like a power meter with thermal head. The measured data are independent of the waveform and in the case of modulated signals, the average power is indicated. In older power meters using diodes, the upper limit of the measurement range is determined at the same time. With the power sensors of the NRV family, the non-linear detector characteristic between 1 mW (0 dBm) and 500 mW (+27 dBm) can now be linearized.

The respective parameters are included in a set of calibration data which are determined for each individual sensor during production and then stored in the pertaining data memory. Although in the extended measurement range - particularly near the upper limit - peak instead of rms weighting is carried out to an increasing extent, RF power measurements can be made with full accuracy provided that a few rules are observed. The spectrum of the RF signal should be pure (low content of harmonics and spurious responses) and, in the case of average-power measurements, it should not be amplitude-modulated. Above 1.5 GHz, an additional error caused by the signal-level-dependent junction capacitance must be taken into account (see Specifications).

In addition to the above-mentioned linearity characteristics, the sensor-specific data memory holds temperature correction values and calibration factors for frequency response correction. While temperature compensation is automatic due to cyclic temperature measurements in the sensor, the test frequency must be entered (via keyboard or IEC bus) if the respective calibration factors are to be taken into account.

2.2 Readout and Reference Impedance (see also section 2.3.5 of NRV manual)

The measured data can be read out as absolute value in W, dBm and V, dBV or relative to a stored reference value or to the value measured in the second channel. Conversion between the first two units and the voltage is made via the reference impedance Z_0 :

$$\text{Voltage}/N = \sqrt{\text{power}/W \times \text{reference impedance}/\Omega} \quad (2-1)$$

The 50- Ω reference impedance of the NRV-Z5 is stored when the data memory is read into the basic unit. The value is indicated when the RLC INP key is pressed or written into the output buffer with IEC-bus command Z1 (see also sections 2.3.5.6 and 2.4.3.2 of NRV manual). It must be emphasized that the reference impedance is the nominal value of the terminating impedance of the sensor and not the true value of the impedance. Therefore, the displayed voltage is not the voltage at the sensor but the rms value of a wave the power of which is measured in a 50- Ω system.

2.3 Measurement Speed and Noise

With older power meters, there is often a relationship between measured power and bandwidth; the smaller the power the narrower the bandwidth. This certainly reduces the noise, but extends the settling time and consequently the useful measurement speed. This relation is extremely useful in manual operation but a disadvantage with remote control. Even in cases where higher noise levels have no effect, the measurement cannot be speeded up. In addition, the user has to determine the required waiting times in order to obtain settled test results.

A different concept has been chosen for the NRV. The user is able to select one of six filters via keyboard or IEC bus (see also sections 2.3.8, 2.3.10, 2.4.3.1 and 2.4.3.2 of NRV manual). Measurement speed and noise for each setting are indicated in the Specifications.

The response times for remote control via IEC bus specified for triggered measurements represent the period between the actual triggering and the output of the first byte. Since internal settling times have already been taken into account, settled measurement results are obtained provided that the test signal is not varied after triggering. To make sure that the response of the instrument in the LOCAL mode is not too slow - particularly when switching from F0 to F2 - intermediate results are displayed. For instance, if filter F0 has been selected in LOCAL operation, a new parameter is indicated every second; in the case of a sudden variation of the test signal, the final result is only indicated after about 15 s. The display noise is halved or doubled between two filter settings. In practice it has proved useful to select either F2 or F4 with the FILTER key (FILTER key illuminated).

In the case of two-channel measurements, the filter can be selected separately for each channel. Since the individual measurements are stacked, the total measurement time is shorter than the sum of the individual measurement times. For instance, with single-channel measurement, the exact measurement time is 0.92 s, and 1.65 s in the case of two-channel measurements.

Since it often happens that low level is measured in one channel only (requiring low display noise), it will be sufficient to use F2 in this channel and, for instance, select F4 in the second. In this case, the total measurement time is 1.00 s.

Table 2-1 shows permissible filter settings for a display noise error of max. 1% (2 standard deviations - see also section 3.5).

Table 2-1 Filter settings for an error of 1% caused by display noise

	200 nW	400 nW	0.8 μ W	1.6 μ W	3.2 μ W	10 μ W	500 mW
F0	x	x	x	x	x	x	x
F1		x	x	x	x	x	x
F2			x	x	x	x	x
F3				x	x	x	x
F4					x	x	x
F5							x

2.4 Zeroing (see also section 2.3.4 of NRV manual)

In addition to the noise, an additive offset of positive or negative polarity may falsify the test result when small powers are measured. This error may be caused for instance by thermal voltages or by switching offsets in the NRV. Under normal conditions, this error will not exceed ± 50 nW so that an adjustment is superfluous with powers above 5 to 50 μ W. Zeroing is initiated by pressing the ZERO key or via IEC bus command 01. With filter settings F1 to F5, about 4 s are required for the adjustment and 15 s for F0. During zeroing, four points light in the display, then the ZERO key lights. The remaining offset must not exceed ± 5 nW or ± 2.5 nW with F0. By pressing the ZERO key once again or with IEC-bus command 00, the offset adjustment can be cancelled. Basically an offset adjustment can be triggered any time, but for reliable adjustment it is advisable to first warm up the basic unit for at least one hour with the sensor connected for a minimum of half an hour. In addition, please note:

Disconnect sensor from the signal source and switch off the RF power!

Zeroing not immediately after measuring higher powers!

Do not move the sensor connecting cable during zeroing!

2.5 Selection of Measurement Range (see also section 2.3.7 of NRV manual)

Generally, it is advisable to use autoranging (**AUTO** key illuminated). However, in some applications it might be better to keep the set measurement range (via keyboard only, **AUTO** key) or to select a range as required.

Range setting via keyboard with the **UP** + and **DOWN** + keys; in the case of remote control with IEC-bus commands RG1 to RG3.

The NRV uses 20-dB steps for range setting (see also Table 2-2). With range selection or holding via keyboard, the new measurement range (as shown in Table 2-2) is briefly indicated in the display. The indicated value corresponds to the voltage pertaining to the nominal power of the selected range according to formula (2-1).

Table 2-2 Measurement ranges

Nominal range	200 μ W	20 mW	2 W
Display range	50 nW to 290 μ W	200 μ W to 29 mW	20 to 550 mW
IEC-bus command	RG1	RG2	RG3
Display with range selection via keyboard	100×10^{-3}	1	10

2.6 Frequency-response Correction

For each NRV sensor, the ratio between displayed and applied power - the so-called calibration factor - is determined during production at a great number of calibration frequencies (see Specifications). These factors are stored in the data memory of the sensor and read in by the basic unit during initialization. Consideration of calibration factors is troublesome with all competitive instruments: the values must be read from a diagram, i.e. additional interpolation is required. Then the value is set with a rotary knob on the basic unit or entered numerically. With the NRV, one merely needs to enter the test frequency via keyboard or IEC bus (see also sections 2.3.5.4, 2.3.9.1 and 2.4.3 of NRV manual) and to switch on the frequency response correction with the **FRQ CORR** key or the IEC-bus command **KF1**.

The NRV then finds the corresponding calibration factors and interpolates linearly between two values if the entered frequency is between two calibration frequencies. In the event that a test frequency has been entered which is outside the calibration frequencies, the calibration factor pertaining to the respective limit frequency will be considered. No extrapolation will be made.

In all cases where frequency response correction is switched off (by pressing the **FRQ CORR** key or via IEC-bus command **KF0** - key illumination goes out), the instrument automatically uses the calibration factor at 50 MHz. Thus measurements up to about 1 GHz can be carried out with a relatively small additional error. This error is not specified in the data sheet.

2.7 PEAK(PEP) Measurements

With the NRV sensors, the peak power can be measured provided that no fast pulses are present. After pressing the **PEAK(PEP)** key or selecting IEC-bus command **E1** (**PEAK(PEP)** key illuminated), the NRV indicates the maximum power of a modulated signal. In the case of an unmodulated RF, there is no difference to the normal measurement - beside the noise at very low powers. The monitoring interval of the crest-value meter in the NRV can be switched together with the filter setting so that, particularly with **F0** to **F3** signals of very low pulse repetition rate can be measured (see PEP measurement in the Specifications).

With pulse-modulated RF (see Fig. 2-1), the permissible pulse width may be within about 200 μ s and CW. The filter effect of the rectifiers in the sensors and the limited bandwidth of the DC amplifier in the NRV cause an additional error particularly in the case of narrow pulses (see Fig. 2-2). The values in the diagram apply to $t_p \ll T$, i.e. an RF pulse of 200 μ s can be measured with fair accuracy even if the pulse occurs only at every 20 s (filter **F0**)! In the case of higher powers and high pulse rate ($T/2 = \text{approx. } t_p$), the occurring errors are always smaller than specified in Fig. 2-2 (peak-weighting of detector, see section 3.6). Thus it causes no problems to measure signals with a pulse width far below 200 μ s.

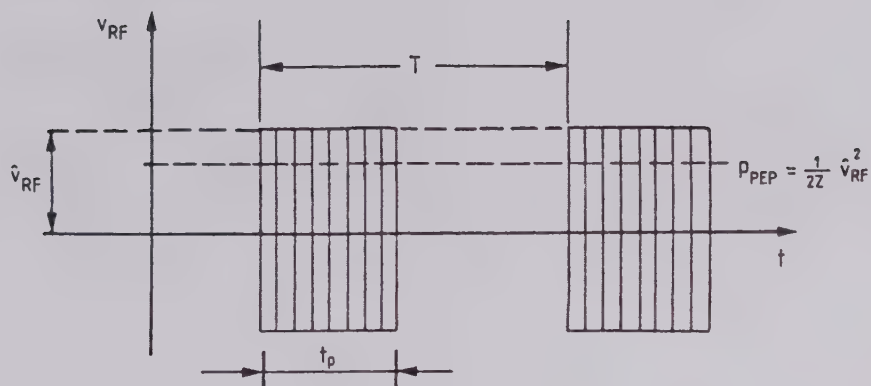


Fig. 2-1 Pulse-modulated RF voltage

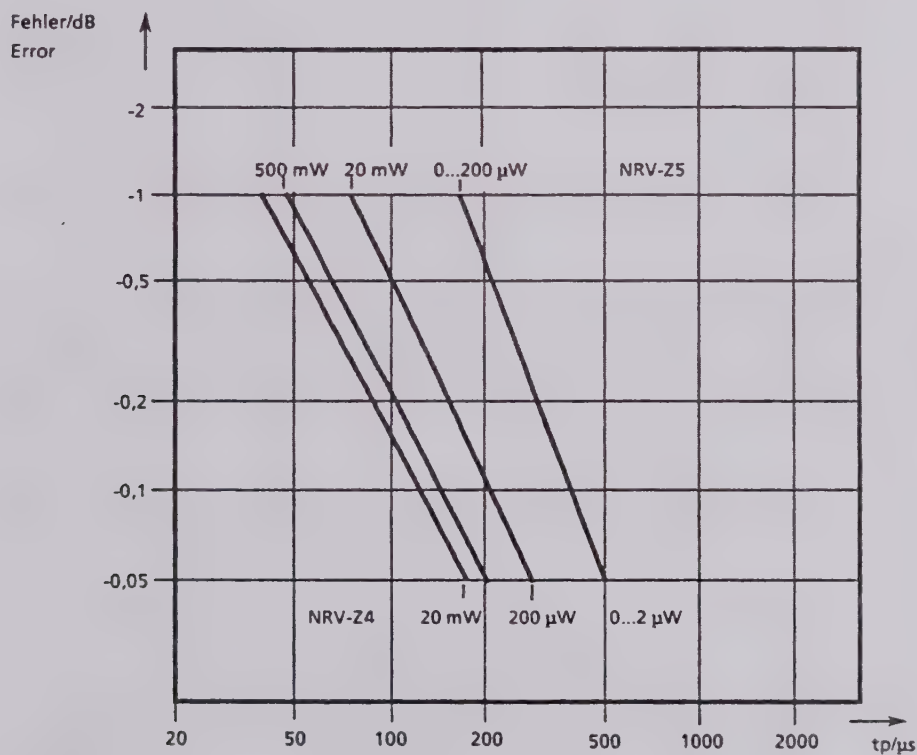


Fig. 2-2 Typ. weighting error with PEAK(PEP) measurements of pulse-modulated RF at various displayed values

3.1 Matching Error

In this section, attention is drawn to an error which is normally ignored because it cannot be stated in the specifications. It is caused by mismatch of power meter and source - which is generally the case in normal practice - and may reach the magnitude of the specified errors. In order to clarify this effect, the behaviour of an ideal power meter (see Fig. 3-1) will be examined.

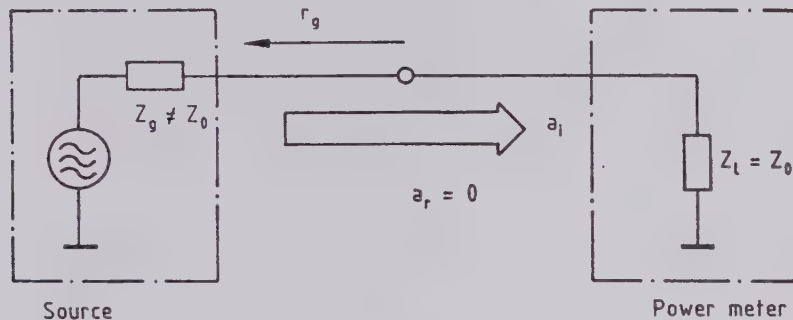


Fig. 3-1 Power measurement with matched power meter

The wave a_i from the generator applied to the line with a reference impedance Z_0 is absorbed reflection-free by the power meter whose impedance Z_l fully matches the reference impedance. The power meter measures the power the source is able to supply to a load with Z_0 . It must be emphasized that this is not the maximum available power that can be delivered in the case of conjugated load matching.

Fig. 3-2 shows a case commonly met in practice where part of the applied power is reflected by the power meter.

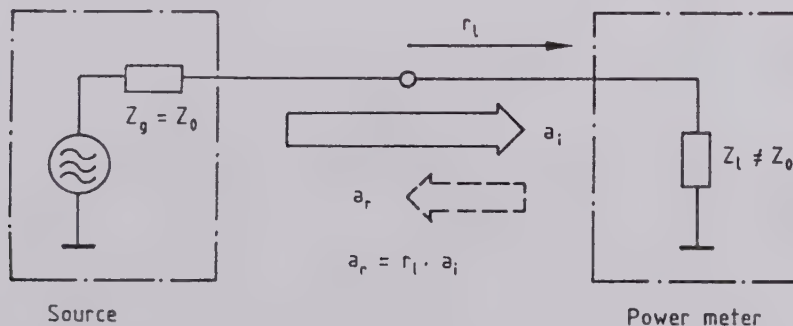


Fig. 3-2 Power measurement with matched source

Suppose that in this special case the generator is matched and the reflected wave is completely absorbed by the source. It is obvious that not the full power the generator could deliver to a matched load is absorbed by the power meter. This measurement error - the so-called **mismatch loss** - may be considered when calibrating the power meter so that it becomes irrelevant to the user.

A realistic case of power measurement with mismatch at both ends is shown in Fig. 3-3.

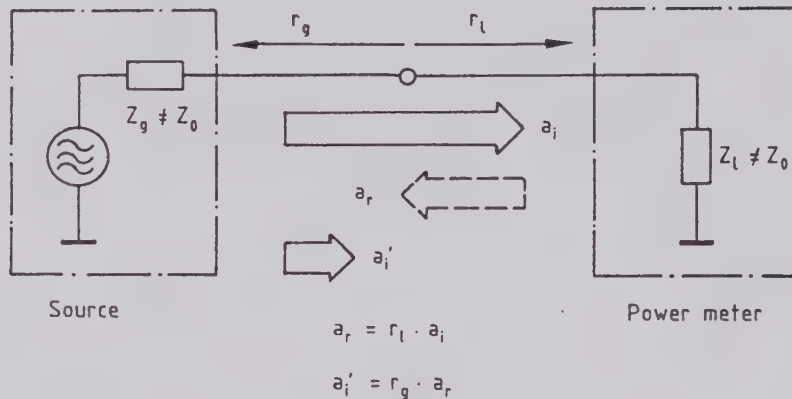


Fig. 3-3 Power measurement with mismatch at both ends

Because of a second reflection - at the generator end - the wave a_i' is added to the wave a_r reflected by the power meter. It is superimposed to the incident wave a_i whose intensity is increased, reduced or unaffected depending on the phase position. Since generally the phase of the wave reflected by power meter and source is unknown, the error caused by multiple reflection cannot be specified. However, it is possible to calculate the maximum possible error, the so-called mismatch uncertainty M_U . Without derivation, the following formula is given:

$$M_U/\% = 100 \left\{ \frac{1}{(1 \pm r_g r_L)^2} - 1 \right\} \quad (3-1)$$

The following approximation is possible:

$$M_U/\% \approx \pm 200 r_g r_L$$

An example in practical application:

Generator: $r_g = 0.20$ (SWR 1.50)

Power meter: $r_l = 0.05$ (SWR 1.11)

$$M_u = \pm 2.0\%$$

This means that in addition to all other errors the user must take an uncertainty of $\pm 2\%$ into account. Supposing the source is already available, the matching error can only be influenced if a low-reflection power sensor is used.

3.2 Error Limits of Calibration Factor

Each NRV power sensor is measured during production at a variety of calibration frequencies (see Specifications: **Error limits of calibration factor**); the measured power is compared to the reference power from the calibration system and the ratio between the two values is stored in the form of a **calibration factor**. Whenever use is made of frequency-response correction, the measured data are first multiplied with the calibration factor pertaining to the frequency. To this end, a linear interpolation is carried out between two calibration frequencies. With instruments of other make, the calibration factor (**Cal factor**) must be taken from a diagram and then set on the instrument or entered.

There are certain inaccuracies when determining the calibration factor in production, caused by the calibration system and by mismatch. R&S specifies in the technical data a maximum error (**worst case uncertainty**) and the RSS ¹⁾ error (**RSS uncertainty**) at the individual calibration frequencies for specific frequency ranges. The maximum error is the algebraic sum of all maximum error values. The RSS error is determined by adding the squares of the individual errors and then taking the square root (see section 3.9: Maximum and RSS Error). While the maximum error allows a fairly conservative error estimate, the RSS error informs on the size of the error to be expected in practice.

All calibration facilities used during production of the NRV sensors are directly derived from the respective national primary standards (PTB, NBS).

The calibration factors are determined at various powers depending on the individual sensor (see Table 3-1).

Table 3-1 Measured power for determining the calibration factor

NRV sensor	Z1	Z2	Z3	Z4	Z5
Measured power	12.6 μ W	1 mW	26.8 μ W	10 μ W	1 mW

¹⁾ RSS: Root sum of the squares

3.3 Linearity Error

With an ideal power meter, the relation

$$P_{dis} = K_b \times P_{inc} \quad (3-2)$$

applies at a certain frequency over the entire dynamic range between the displayed power P_{dis} ¹⁾ and the power of the incoming wave P_{inc} . K_b is the calibration factor; matching errors are ignored. With real-power meters, this formula only applies at the calibration point (see Fig. 3-4). Towards lower and particularly higher powers, deviations from these physical characteristics may occur, the linearity error E_l :

$$E_{lin}/\% = 100 \{ P_{dis}/(K_b P_{inc}) - 1 \} \quad (3-3)$$

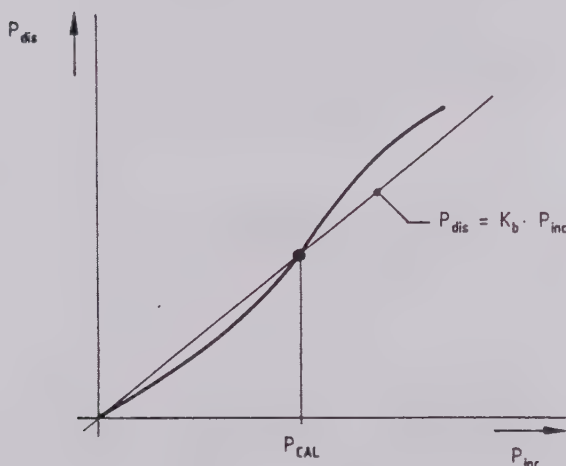


Fig. 3-4 Linearity error

The linearity error may be added to the previously mentioned errors without further conversion. R&S specifies the linearity error for a calibration temperature $23 \pm 1^\circ\text{C}$ at 50 MHz. With 0.3 to 0.4%, this error is relatively small compared to that of competitive equipment which have no facility for individual linearization of the sensor.

For the two power sensors NRV-Z1/-Z2 (-Z4/-Z5) the specified linearity error applies for a frequency up to 4(1.5) GHz. For higher powers ($>20 \mu\text{W}$ for NRV-Z1/-Z4, $>2 \text{ mW}$ for NRV-Z2/-Z5) an additional error caused by the power-dependent junction capacitance of the detector may occur. The error increases with increasing frequency and power to be measured. Therefore the specified data must only be expected at the upper limits of the respective intervals. Fig. 3-5 shows the power and frequency-dependent measured reaction of NRV-Z1/-Z2. The error always has a positive sign, i.e. it increases the displayed power.

¹⁾ Without frequency-response correction

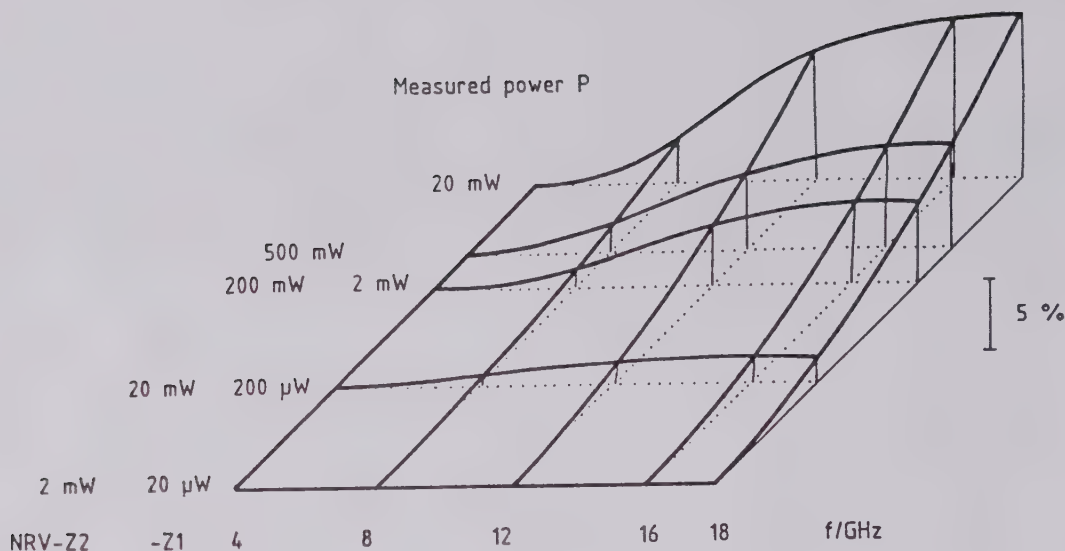


Fig. 3-5 Frequency-dependent additional error

3.4 Zero Error

The zero error is a residual error after zeroing causing an additive (power) offset which is almost invariable with time and only slightly influenced by the ambient temperature as long as no sudden temperature changes occur. In the R&S specifications, the zero error is a maximum error that may occur within one hour after zeroing, changes in ambient temperature of $\pm 1^\circ\text{C}$ being permissible.

If zeroing is carried out while filter F0 is selected, half the value may be expected for a brief period of time (see section 2.4).

3.5 Display Noise

Since this is a random noise, no maximum values can be specified. For this reason, R&S specifies a value which is twice the standard deviation. Consequently it can be assumed with a 95% certainty that the measured value will not deviate from the indicated average power by more than this amount. The measurement is carried out with filter setting F2 for about 1 min. (64 measured values, trigger mode X4). The standard deviation s may then be calculated according to the formula

$$s = 1/8 \sqrt{\sum_{i=1}^{64} (P_i - \bar{P})^2} \quad (3-4)$$

P_i = individual measurement

$\bar{P}$ = average value of 64 individual measurements

Like the zero error, the display noise is an additive quantity independent from the measured power.

3.6 Weighting Error

An ideal power meter displays the true power of the input signal independent of the waveform. Although no sawtooth or squarewave voltages are measured at high frequencies, distorted sinewave signals comprising harmonics or even spurious resonances must be expected. In this case, the microwave power meter is ideal. It measures the total power i.e. the sum of the individual powers measured at the various frequencies. Even if only the power of the fundamental is of interest, the error caused by unwanted components is low considering that a noise signal of -26 dBc increases the power indication by only 0.25%.

The behaviour of sensors with diodes such as NRV-Z1 to Z5 is less ideal over the entire dynamic range. While small powers are measured with true rms values (as in the microwave power meter), peak weighting of the input signal is carried out to an increasing extent towards the upper range limit. Under unfavourable conditions, an interfering signal of -26 dBc may cause an error of $\pm 10\%$ in power indication.

Table 3-2 shows limits for the power ranges in which powers are measured with true rms values or in which weighting errors must be expected.

Table 3-2 Weighting

Sensor	Rms weighting	Weighting error possible	k
-Z1/-Z4	1 nW to 10 μ W	10 μ W to 20 mW	1.0
-Z2/-Z5	100 nW to 1 mW	1 mW to 500 mW	0.01
-Z3	400 pW to 7 μ W	7 μ W to 13 mW	1.5

With the aid of formula (3-5), the error caused by one single noise component can be assessed.

$$E_W/\% = \frac{200}{1 + 200 \mu\text{W}/kP} \times 10^{S/20} \text{ dB} \quad (3-5)$$

E_W : Error of power indication

P: Measured power

k: see Table 3-2

S: S/N ratio in dB

Example: Measurement with NRV-Z2, P = 100 mW, S = -32 dBc

Result obtained with formula (3-5): $E_W = \pm 4.2\%$

Formula (3-5) applies very exactly to the error at the 3-fold fundamental frequency (3rd harmonic). For the 2nd harmonic, the resulting error is somewhat greater; for all higher harmonics, the errors are smaller than calculated with formula 3-5.

In the case of power sensors NRV-Z3...Z5, the even harmonics of low order (double, 4-fold, 6-fold fundamental frequency) produce negligibly small weighting errors because of the full-wave rectification used.

3.7 Error of Basic Unit

The analog section of the NRV mainly consists of highly accurate DC amplifiers and a high-resolution A/D converter. The specified error is caused by the drift of the gain ratios (time, temperature) and like all other errors it is referred to the measured value. Since normally the typical error is even smaller, the error caused by the basic unit may be neglected in comparison to the other uncertainties of measurement.

3.8 Temperature Effect

Outside the range from 18 to 28 °C, an additional error may occur in the basic unit (maximum error specified).

Without correction, the sensors have a very high temperature coefficient that lies between -0.3 and -0.5%/°C. With the aid of cyclic temperature measurements in the sensor and a correction software based on a diode model matched to the specific sensor, the residual error can be reduced to typically 0.07%/°C. The typical errors to be expected in various frequency ranges and guaranteed maximum values are given in the Specifications.

3.9 Maximum and RSS Error

Specifying errors for a specific test setup is basically a matter of trustworthiness. Error calculation is simple if only a few parameters are concerned, but in the case of measurements involving a large number of error sources, the discrepancy between the maximum calculated error and the error actually incurred will become evident.

For this reason, two errors are usually stated when making power measurements: the maximum error $E_{\max}$ as sum of all individual maximum errors $(E_{\max})_i$ (see formula (3-6)) and the so-called E_{RSS} , a more practice-oriented error (formula (3-7)).

$$E_{\max} = \sum_{i=1}^N (E_{\max})_i \quad (3-6)$$

$$E_{\text{RSS}} = \sqrt{\sum_{i=1}^N (E_{\text{RSS}})_i^2} \quad (3-7)$$

The RSS value is the square root from the sum of squares of the individual RSS errors $(E_{\text{RSS}})_i$. If only the maximum value is available for one of the error components, it should be inserted in the formula (this will generally be the case). It must however be noted, that only **average-free** error components may be used in RSS calculations; i.e. an error of for instance +0.8% must be as probable as an error of -0.8%. This can be assumed for all error components except for the frequency-dependent additional error described in section 3.3. How can this frequency-dependent additional error be considered in the RSS calculation? First determine the RSS value from all other components and then add the mentioned error.

Example:

$$(E_{\max})_1 = \pm 2.8\% \quad (E_{\max})_2 = \pm 2.5\% \quad (E_{\max})_3 = \pm 1.5\%$$

$$(E_{\text{RSS}})_1 = \pm 1.6\%$$

Suppose the frequency dependent additional error

$$(E_{\max})_4 = +3.0\%$$

$$\underline{E_{\max} = -3.8/+9.8\%}$$

$$\underline{E_{\text{RSS}} = -0.3/+6.3\%}$$

The definition of the RSS value, which seems at first arbitrary, is based on a known law of the probability calculus: with a total error representing the sum of several individual errors, the sum error approaches the Gaussian distribution as the number of error components increases. The standard deviation of the sum error equals the square root of the sum of squares for the individual standard deviations. This is fairly accurately in agreement with the law for the RSS value with the only difference that the RSS or maximum value is used instead of the standard deviation. Depending on the distribution function of the individual errors, the RSS value corresponds to 2 to 3 standard deviations; this also applies to the result obtained.

Consequently:

The RSS value of a sum of individual errors can be regarded as the error which is not exceeded in 95% of all measured data.

3.10 A Practical Example of Error Analysis

Given quantities:

Generator $r_g = 0.15$ (SWR 1.35)
 $P = 10 \mu\text{W}/12 \text{ GHz}$

Power meter NRV-Z2, filter F4 $T_a = 24^\circ\text{C}$

The individual errors have been taken from the NRV/NRV-Z2 specifications.

Error source	Manual	Component (E_{max})		Component (E_{RSS})
		%	dB	%
Matching $r_g = 0.15$ $r_l = 0.07$	Formula (3-1)	± 2.1	-0.0927 +0.0907	± 2.1
Cal factor $\pm 5.4\%$ ($\pm 2.8\%$)	Section 3.2	± 5.4	-0.2284 +0.2411	± 2.8
Linearity	Section 3.3	± 0.3	-0.0130 +0.0130	± 0.3
Zero point $\pm 10 \text{ nW}$	Section 3.4	± 0.1	-0.0043 +0.0043	± 0.1
Noise 64 nW	Section 3.5	± 0.6	-0.0279 +0.0277	± 0.6
Basic unit	Section 3.7	± 0.3	-0.0130 +0.0130	± 0.3
Weighting	Section 3.6	± 0.0	-0.0000 +0.0000	± 0.0
Temperature	Section 3.8	± 0.0	-0.0000 +0.0000	± 0.0
Total error		± 8.8	-0.3793 +0.3898	± 3.6

If the total error in dB is converted into the corresponding error in %, the result is $-8.4/+9.4\%$. The difference to the specified value of $\pm 8.8\%$ is due to the fact that, strictly speaking, formula (3-6) is only an approximation of the sum of **relative errors**.

3.11 List of Symbols Used

$a_i^{1)}$	Incident wave with matched generator
$a_i'^{1)}$	Component of incident wave resulting from multiple reflection
$a_r^{1)}$	Reflected wave
E_{lin}	Linearity error
E_w	Weighting error (only with power measurement with semiconductor diodes)
E_{max}	Maximum value of total error
E_{RSS}	RSS value of total error
f	Frequency
i	Index for identification of an individual measurement or an error component
k	Scaling factor (formula 3-5)
K_b	Calibration factor
M_u	Mismatch uncertainty
P	Power, general
P_{dis}	Displayed power
P_{inc}	Power of incident wave
P_{PEP}	Max. peak envelope power
$\bar{P}$	Average value of several power measurements
r_g	Reflection coefficient of generator
r_l	Reflection coefficient of load

- ¹⁾ The wave magnitudes a_i , a_i' , and a_r are complex pointers for representation of the wave propagation referred to magnitude and phase (network analysis with s-parameters). The following relation exists between a wave a and the power P transported by a:

$$|a| = \sqrt{P}$$

s	Standard deviation of display noise
S	S/N ratio
T	Period
t_p	Pulse width
T_U	Ambient temperature
u_{HF}	RF voltage, instantaneous value
$\hat{u}_{HF}$	RF voltage, peak value
Z_g	(Internal) impedance of generator
Z_l	Impedance of load
Z_0	Reference impedance (real)

Power and reflection measurements in the frequency range up to 18 GHz require experience and special care because of the manifold error sources.

For this reason, the guaranteed characteristics should only be measured by the respective calibration or service shops of Rohde & Schwarz where suitable test setups are available for such measurements. If the user still wishes to carry out these measurements on his own, he should in any case be well aware of the measurement uncertainties of the chosen test setup. A careful study of section 3 is recommended in this case.

The NRV sensors require no maintenance and offer stable electrical characteristics. A yearly check will be sufficient (section 4).

Defective probes or those out of tolerances must be returned to the manufacturer for repair/calibration.

At present, only the manufacturer is able to enter the calibration parameters into the data memory.

The date of the last calibration can be output using the special command SP (see NRV manual, section 2.4.3).



ROHDE & SCHWARZ

Liste mechanischer Teile

List of mechanical parts

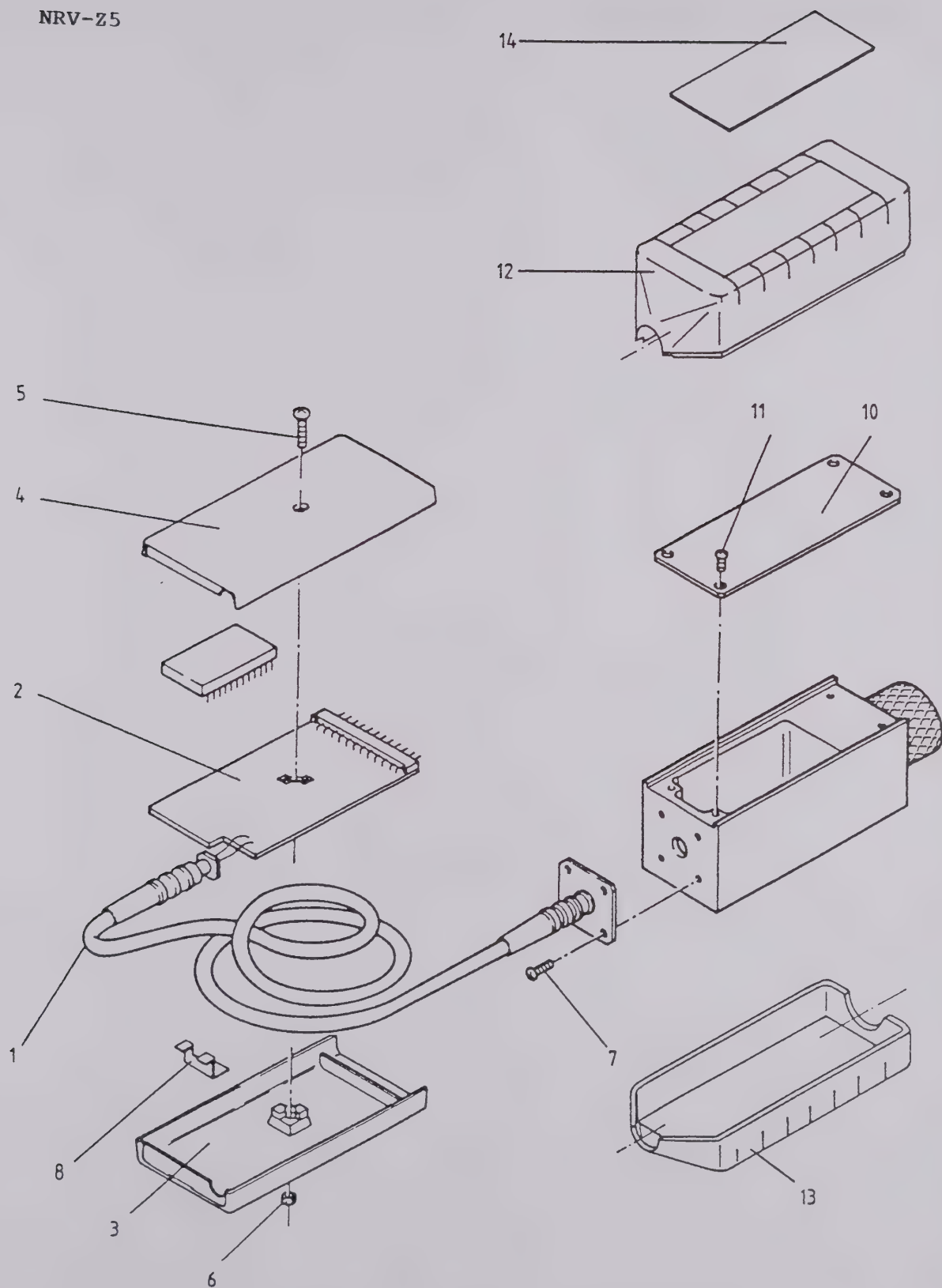
Bilder zur Liste mechanischer Teile

Figures pertaining to list of mechanical parts

Liste zu Bild 5-1

List for Fig. 5-1

Lfd. Nr.	Kenn- zeichen	Stück- zahl	Benennung/Beschreibung	Sachnummer
No.	Unit/ Comp.No	Qty	Designation	Stock No.
1	W1	1	DX Kabel Cable (VAR/MOD 02)	828.3476.02
			DX Kabel, 5 m lang Cable, 5 m length (VAR/MOD 03)	828.3476.05
2		1	ED Datenspeicher Data memory	395.2915.02
3		1	Unterteil, metallisiert Bottom plate, metal-coated	395.0612
4		1	Oberteil, metallisiert Top plate, metal-coated	395.0635
5		1	VS M 2x10 DIN 7985 A4	VS 081.8942
6		1	VS M2 DIN 934 A4	VS 061.5225
7		4	VS M 2x6 DIN 7985 A4	VS 081.8920
8		1	MZ Kontaktfeder Contact spring	395.0658
10		1	MZ Deckel Cover plate	358.2321
11		4	VS M 2x5 DIN 7985 A4	VS 088.3123
12		1	MP Tastkopfschale, oben Probe casing, top	238.2883
13		1	MP Tastkopfschale, unten Probe casing, bottom	238.2890
14		1	OS Schild, mit SER-Nr. Label with serial number VAR/MOD 02	828.3682
			VAR/MOD 03	828.3699





ROHDE & SCHWARZ

Schaltteillisten
numerisch geordnet

Part lists
in numerical order

Listes des pièces détachées
par numéros de référence

Kennz. Comp. No.	Benennung Designation	Sachnummer Stock No.	Hersteller Manufacturer	Bezeichnung Designation	enthalten in contained in
.	XX VARIANTENERKLAERUNG IDENTIFICATION OF MODELS VAR 02 = GRUNDAUSFUEHRUNG MOD 02 = BASIC MODEL VAR 03 =MIT ANSCHLUSSKABEL 5M LANG MOD 03 =WITH CONNECTING CABLE, 5M LENGTHS .. XX ZUEGH.STROML. CIRC.DIAGR. 828.3818 S				
A1	ED DATENSPEICHER III	0395.3063.02			0828.4214.01
A2	ED ANSCHLUSSPLATTE NUR VAR/ONLY MOD: 02 04	0828.4250.02			0828.4214.01
A2	ED ANSCHLUSSPLATTE NUR VAR/ONLY MOD: 22 44	0828.4250.22			0828.4214.01
A2	ED ANSCHLUSSPLATTE NUR VAR/ONLY MOD: 23 46	0828.4250.23			0828.4214.01
A2	ED ANSCHLUSSPLATTE NUR VAR/ONLY MOD: 24	0828.4250.24			0828.4214.01
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 02 22 23 24	0395.1090.02			0828.4214.01
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 04 44 46	0395.1090.05			0828.4214.01

Kennz. Comp. No.	Benennung Designation	Sachnummer Stock No.	Hersteller Manufacturer	Bezeichnung Designation	enthalten in contained in														
	XX VARIANTENERKLÄRUNG IDENTIFICATION OF MODELS VAR02=GRUNDAUSFUEHRUNG MOD02=BASIC_MODEL VAR22=FUER NRV-Z3 MOD22=FOR NRV-Z3 VAR23=FUER NRV-Z4 NRV-Z5 MOD23=FOR NRV-Z4 NRV-Z5 VAR24=FUER NRV-Z6 MOD24=FOR NRV-Z6																		
C4	CC 33NF+-10% 25V HDK 0603 CERAMIC CHIP CAPACITOR	1051.4697.00	AVX	CM105X7R333K25VAT															
C6	CC 1,0NF+-10%50V HDK 0603 SMD-CERAMIC-CAPACITOR	CC 0009.4938.00	MURATA	GRM39X7R***K5C500PT*															
C7	CC 1,0NF+-10%50V HDK 0603 SMD-CERAMIC-CAPACITOR NICHT BESTUECKT NOT FITTED	CC 0009.4938.00	MURATA	GRM39X7R***K5C500PT*															
C8	CC 1,0NF+-10%50V HDK 0603 SMD-CERAMIC-CAPACITOR NUR VAR/ONLY MOD: 02	CC 0009.4938.00	MURATA	GRM39X7R***K5C500PT*															
C8	CC 100NF+-10%16V HDK 0603 CERAMIC CHIP CAPACITOR NUR VAR/ONLY MOD: 23	1097.6292.00	PHILIPS_CO	2238 786 16649															
C8	CC 1,0NF+-10%50V HDK 0603 SMD-CERAMIC-CAPACITOR NUR VAR/ONLY MOD: 24	CC 0009.4938.00	MURATA	GRM39X7R***K5C500PT*															
C9	CC 1,0NF+-10%50V HDK 0603 SMD-CERAMIC-CAPACITOR NUR VAR/ONLY MOD: 24	CC 0009.4938.00	MURATA	GRM39X7R***K5C500PT*															
R1	RG 100R +-1% TK200 0603 SMD-RESISTOR EIA0603 NUR VAR/ONLY MOD: 22	RG 0009.5334.00	DRALORIC	CR 0603															
..1																			
R2	RG 100R +-1% TK200 0603 SMD-RESISTOR EIA0603 NUR VAR/ONLY MOD: 02	RG 0009.5334.00	DRALORIC	CR 0603															
R2	RG 100R +-1% TK200 0603 SMD-RESISTOR EIA0603 NUR VAR/ONLY MOD: 23	RG 0009.5334.00	DRALORIC	CR 0603															
R2	RG 22K +-1% TK200 0603 SMD-RESISTOR EIA0603 NUR VAR/ONLY MOD: 24	0009.7050.00	DRALORIC	CR 0603															
R3	RG 100R +-1% TK200 0603 SMD-RESISTOR EIA0603 NUR VAR/ONLY MOD: 22	RG 0009.5334.00	DRALORIC	CR 0603															
R3	RG 100R +-1% TK200 0603 SMD-RESISTOR EIA0603 NUR VAR/ONLY MOD: 23	RG 0009.5334.00	DRALORIC	CR 0603															
R3	RG 1K0 +-1% TK200 0603 SMD-RESISTOR EIA0603 NUR VAR/ONLY MOD: 02	RG 0009.5340.00	DRALORIC	CR 0603															
R3	RG 100R +-1% TK200 0603 SMD-RESISTOR EIA0603 NUR VAR/ONLY MOD: 24	RG 0009.5334.00	DRALORIC	CR 0603															
U1	BJ LM335M TEMP.SENSOR PRECION TEMP.SENSOR	0395.1519.00	NSC	LM335M															
X1	FP STIFTELEISTE 7P. SMD CONNECTOR	FP 1081.2386.00	SPEED_TECH	H761-8201-078															
X7	VL EINPRESSSTIFT L=6,8 PIN NICHT BESTUECKT/NOT FITTED	VL 0010.7250.00	AMP	1-928776-5															
X8	VL EINPRESSSTIFT L=6,8 PIN NICHT BESTUECKT/NOT FITTED	VL 0010.7250.00	AMP	1-928776-5															
X9	VL EINPRESSSTIFT L=6,8 PIN NICHT BESTUECKT/NOT FITTED	VL 0010.7250.00	AMP	1-928776-5															
Z1 ..6	LD T-FILTER 100PF SMD SMD-FILTER	1039.1356.00	MURATA	NFM61ROOT101T1															
<table><tr><td>1GPK</td><td>620 3PUA</td><td>ÄI</td><td>Datum Date</td><td>Schaltteilleiste für Parts list for</td><td>Sachnummer Stock No.</td><td>Blatt-Nr. Page</td></tr><tr><td colspan="2"></td><td>02</td><td>06.08.98</td><td>ED ANSCHLUSSPLATTE</td><td>0828.4250.01 SA</td><td>1-</td></tr></table>						1GPK	620 3PUA	ÄI	Datum Date	Schaltteilleiste für Parts list for	Sachnummer Stock No.	Blatt-Nr. Page			02	06.08.98	ED ANSCHLUSSPLATTE	0828.4250.01 SA	1-
1GPK	620 3PUA	ÄI	Datum Date	Schaltteilleiste für Parts list for	Sachnummer Stock No.	Blatt-Nr. Page													
		02	06.08.98	ED ANSCHLUSSPLATTE	0828.4250.01 SA	1-													

Kennz. Comp. No.	Benennung Designation	Sachnummer Stock No.	Hersteller Manufacturer	Bezeichnung Designation	enthalten in contained in
	XX VARIANTENERKLAERUNG IDENTIFICATION OF MODELS VARO2=GRUNDAUSFUEHRUNG MODO2=BASIC_MODEL				
C1	CC 470NF+-10%50V X7R 1812	CC 0007.7498.00	AVX	1812 5C 474KA T00F	
..3	CERAMIC CHIP CAPACITOR				
C4	CC 33NF+-10% 25V HDK 0603	1051.4697.00	AVX	CM105X7R333K25VAT	
..6	CERAMIC CHIP CAPACITOR				
C7	CC 47PF+-1% 50VNPO 0603	CC 0009.4644.00	MURATA	GRM39COG***F50PT	
	SMD-CERAMIC-CAPACITOR				
C8	CC 47PF+-1% 50VNPO 0603	CC 0009.4644.00	MURATA	GRM39COG***F50PT	
	SMD-CERAMIC-CAPACITOR				
C9	CC 1,0NF+-10%50V HDK 0603	CC 0009.4938.00	MURATA	GRM39X7R***K5C500PT*	
	SMD-CERAMIC-CAPACITOR				
D1	BC N28F010 128KX8FL.EPROM	0007.9861.00	AMD	AM28F010-150JC	
D2	BG TH3063.1I MEK0LO ASIC	0857.8350.00	THESYS	TH3063.1I	
	IC GATEARRAY				
N1	B0 LP2951CML0WDROP +VREGL	1020.0890.00	NSC	LP2951CM	
	IC VOLTAGE REGULATOR				
P1	VL EINPRESSSTIFT L=6,8	VL 0010.7250.00	AMP	1-928776-5	
	PIN				
	NICHT BESTUECKT				
	NOT FITTED				
P2	VL EINPRESSSTIFT L=6,8	VL 0010.7250.00	AMP	1-928776-5	
	PIN				
	NICHT BESTUECKT				
	NOT FITTED				
R1	RG 10K +-1% TK200 0603	RG 0009.5357.00	DRALORIC	CR 0603	
	SMD-RESISTOR EIA0603				
R2	RG 825R +-1% TK200 0603	0010.8391.00	DRALORIC	CR 0603	
..5	SMD-RESISTOR EIA0603				
R6	RG 1K0 +-1% TK200 0603	RG 0009.5340.00	DRALORIC	CR 0603	
	SMD-RESISTOR EIA0603				
R7	RG 100K +-1% TK200 0603	RG 0009.5363.00	DRALORIC	CR 0603	
..13	SMD RESISTOR				
R14	RG 2K2 +-1% TK200 0603	0009.7008.00	DRALORIC	CR 0603	
	SMD-RESISTOR EIA0603				
S1	SK CODIERSCH..2P.2XEIN	1081.0190.00	C&K	DMR-02-T(R)	
	DIP-SWITCH				
S2	SK CODIERSCH..2P.2XEIN	1081.0190.00	C&K	DMR-02-T(R)	
	DIP-SWITCH				
V1	AE BZV55/C15 0,5W ZDI	AE 0006.9900.00	PHILIPS_SE	BZV55B15	
	ZENER DIODE				
V2	AK BC860B P 45V 200MA	AK 0007.7975.00	MOTOROLA	BC860B	
	TRANSISTOR				
V3	AM SI9948DY P-E DUAL MOSF	0395.1525.00	SILICONIX	SI 9948 DY	
	DUAL P-CH E-MODE MOSFET				
V4	AK BC860B P 45V 200MA	AK 0007.7975.00	MOTOROLA	BC860B	
	TRANSISTOR				
V7	AE BZV55/C6V2 0,5W ZDI	AE 0006.9851.00	PHILIPS	BZV55B6V2	
	ZENER DIODE				
V8	AE BZV55/C7V5 0,5W ZDI	AE 0007.3428.00	PHILIPS_SE	BZV55B7V5	
	ZENER DIODE				
X1	FP STIFTELEISTE 8POL.WINK.	1081.1750.00	LACON	070-51-03-128-008	
	CONNECTOR				
X10	FP IND.STECKERLEISTE 12P.	0516.0200.00	BINDER	10-9839-00-12	
	CONNECTOR				

1GPK	620	3PUA	ÄI	Datum Date	Schaltteilleiste für Parts list for	Sachnummer Stock No.	Blatt-Nr. Page
				02	06.08.98	ED DATENSPEICHER III	0395.3063.01 SA
							1-



XY-Liste

XY List

Erklärung der Spaltenbezeichnungen:

- Part:** Bauelement-Kennzeichen.
- Side:** Leiterplatten-Seite, auf der sich das Bauelement befindet.
- X/Y:** Koordinaten (Millimeter) des Bauelementes auf der Leiterplatte bezogen auf den Nullpunkt.
- SQR, PG:** Planquadrat und Seite des Schaltbildes für das jeweilige Bauelement.

Explanation of column designations:

- Part:** Identification of instrument part.
- Side:** Side of the PC board on which instrument part is positioned.
- X/Y:** Coordinates (millimeter) of the component on the PC board in reference to zero point.
- SQR, PG:** Square and page of the diagram for the respective instrument part.

Nicht-Service-Relevante Bauteile / Non-Service-Relevant Components																	
Part Side X Y Sqr Pg						Part Side X Y Sqr Pg						Part Side X Y Sqr Pg					
C4	B	7	13	2C	1	R3	B	4	11	2A	1	Z2	B	7	3	2B	1
C6	B	8	20	2C	1	U1	B	5	21	2C	1	Z3	B	9	12	2C	1
C7	B	7	11	2A	1	X1	B	22	6	3B	1	Z4	B	9	15	2C	1
C8	B	7	7	2B	1	X7	B	2	14	2A	1	Z5	B	9	17	2C	1
C9	B	5	3	2B	1	X8	B	2	5	2B	1	Z6	B	9	10	2A	1
R1	B	4	7	2B	1	X9	B	2	9	2B	1						
R2	B	3	5	2B	1	Z1	B	9	7	2B	1						

ROHDE & SCHWARZ	ÄI	Datum Date	XY-Liste für XY-list for	Sach-Nummer Stock-Nr	Blatt Page
	01	07.11.96	ED ANSCHLUSSPLATTE PROBE_BOARD	828.4250.01 XY	1-

Nicht-Service-Relevante Bauteile / Non-Service-Relevant Components																	
Part Side X Y Sqr Pg						Part Side X Y Sqr Pg						Part Side X Y Sqr Pg					
C1	B	23	3	5B	1	P2	B	41	24	5D	1	S1	B	54	20	3D	1
C2	B	12	3	4A	1	R1	B	35	25	5D	1	S1	B	54	20	3D	1
C3	B	7	15	3F	1	R2	B	37	27	2C	1	S2	B	54	27	3C	1
C4	B	10	9	8E	1	R3	B	37	30	2C	1	S2	B	54	27	3D	1
C5	B	10	11	8E	1	R4	B	37	23	2D	1	V1	B	34	8	3B	1
C6	B	10	13	8E	1	R5	B	37	29	2D	1	V2	B	25	8	3A	1
C7	B	1	19	6C	1	R6	B	36	32	5D	1	V3	B	20	9	4B	1
C8	B	1	34	6C	1	R7	B	10	7	8E	1	V3	B	20	9	6A	1
C9	B	37	34	5D	1	R8	B	30	6	3A	1	V4	B	27	11	5B	1
D1	B	8	19	3F	1	R9	B	31	8	3A	1	V7	B	34	12	6B	1
D1	B	8	19	6D	1	R10	B	22	13	5A	1	V8	B	10	16	5C	1
D2	B	25	17	2F	1	R11	B	30	13	6B	1	X1	B	55	15	3E	1
D2	B	25	17	5C	1	R12	B	31	11	6B	1	X10	B	58	4	2E	1
N1	B	20	2	4A	1	R13	B	22	10	3B	1						
P1	B	41	27	5D	1	R14	B	6	10	2E	1						

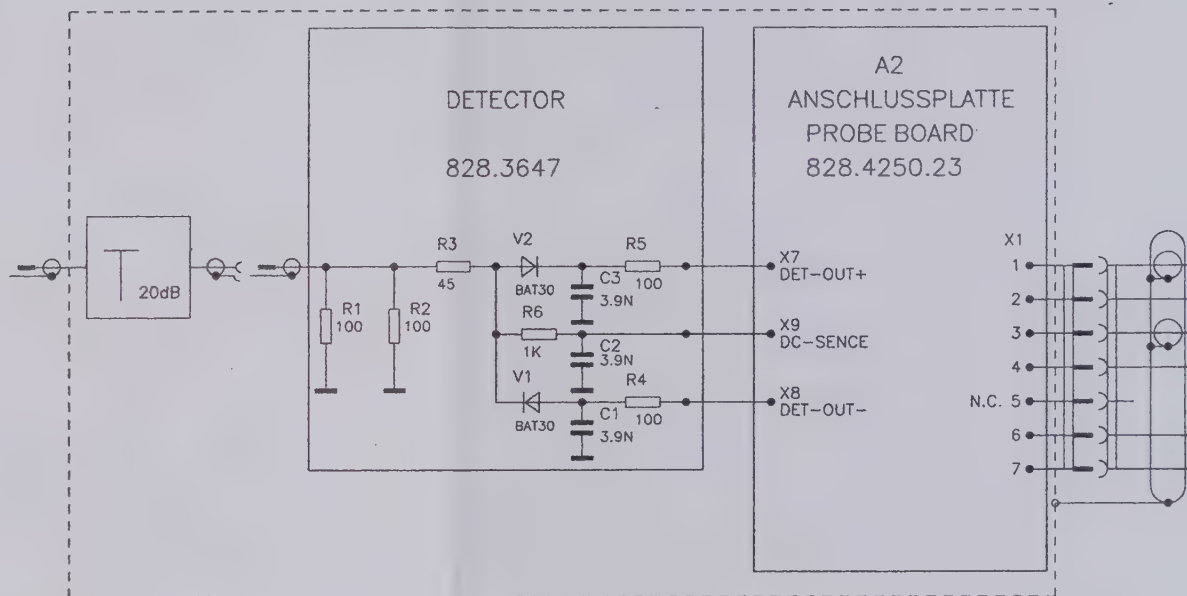
ROHDE & SCHWARZ	ÄI	Datum Date	XY-Liste für XY-list for	Sach-Nummer Stock-Nr	Blatt Page
		03 14.11.96	ED DATENSPEICHER_III MEMORY_III	395.3063.01 XY	1-



ROHDE & SCHWARZ

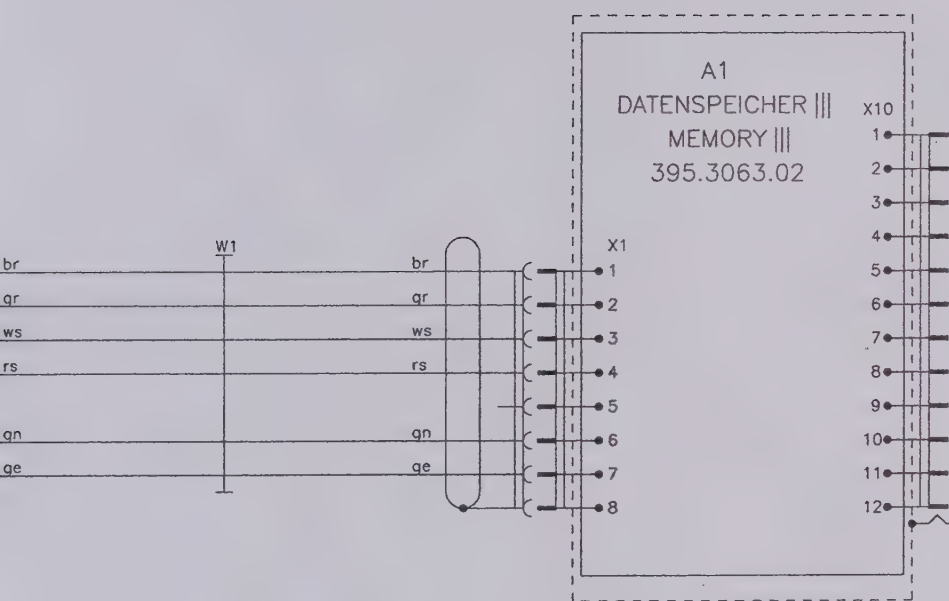
Stromläufe
Bestückungspläne
Circuit diagrams
Components plans
Schémas de circuit
Plans des composants

FUER DIESE UNTERLAGE
BEHALTEN WIR UNS ALLE RECHTE VOR



ROHDE & SCHWARZ

04								1GPK	Datum	Name
								Bearb.	22.01.97	SR
								Gepr.		SR
Aend. Zust.	Aenderungsmitteilung	Datum	Name	Aend. Zust.	Aenderungsmitteilung	Datum	Name	Norm		

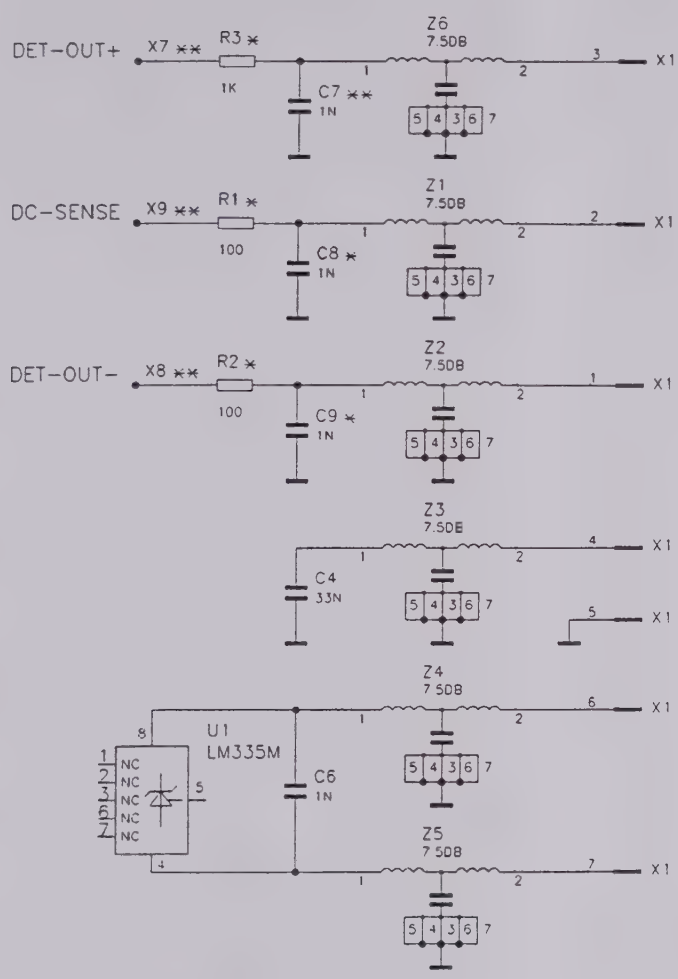


PROBE	A1 MEMORY III			
	S1a	S1b	S2a	S2b
NRV-Z5	off	off	off	off

ACHTUNG: EGB !
ELEKTROSTATISCH GEFÄHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG.
ATTENTION ESD !
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING

VARIANTENERKLÄRUNG/VERSIONS
VAR02 = GRUNDAUSFÜHRUNG
MOD02 = BASIC MODEL
VAR03 = MIT 5M ANSCHLUSSKABEL
MOD03 = WITH CONNECTING CABLE 5M LENGTHS

BEHALTEN WIR UNS ALLE RECHTE VOR



* = MODEL PART
** = NOT FITTED

Bindende Angaben ueber Varianten,
Trimmwerte, Bauteile und
nicht bestueckte Bauteile siehe SA.

FOR BINDING INFORMATION ON MODELS,
TRIMMING AND COMPONENTS VALUES AND
NONFITTED COMPONENTS SEE PARTS LIST

MOD / VAR	R1	R2	R3	C8	C9
02 NRV-Z1/-Z2	**	100	1K	1N	**
22 NRV-Z3	100	100	100	**	**
23 NRV-Z4/-Z5	1.82K	100	100	100N	**
24 NRV-Z6	**	22K	100	1N	1N



ACHTUNG EGB !
ELEKTROSTATISCH GEFÄHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG
ATTENTION ESD !
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING

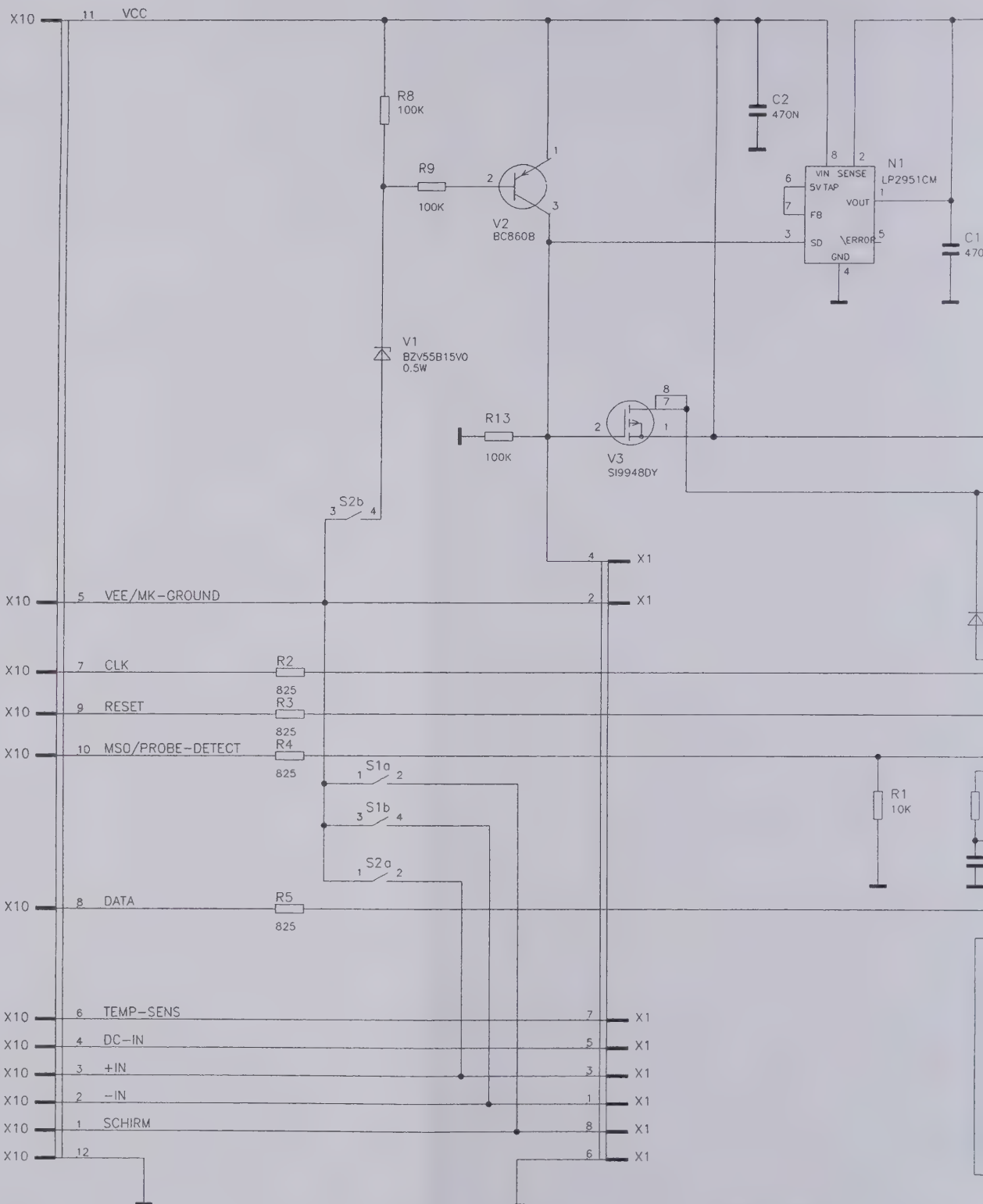
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				BEARB		BU		
				GEPR.		BU		
				NORM				
				PLOTT	24 1 97	BAUR_A		
ROHDE&SCHWARZ								
AEND.	AENDERUNGS-	DATUM	NAME					

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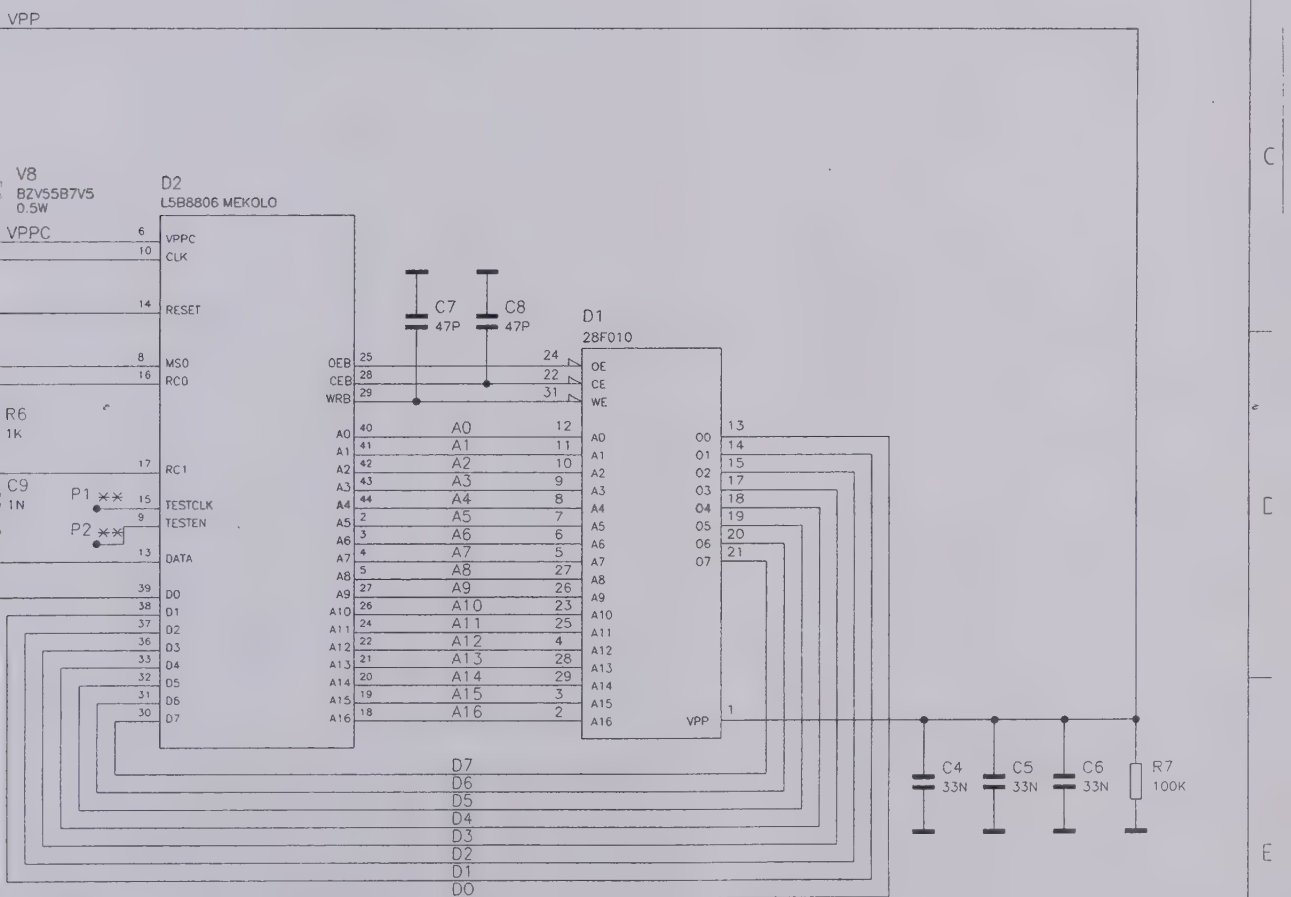
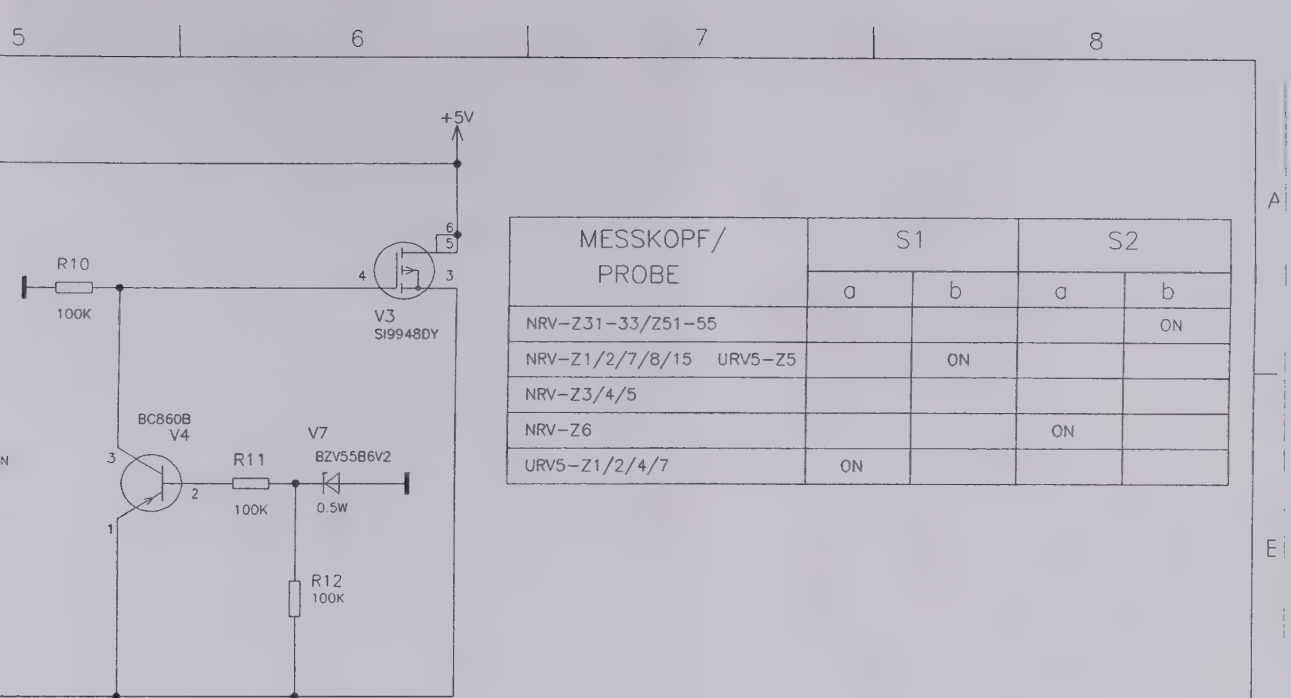
** = NOT FITTED

Bindende Angaben ueber Varianten,
Trimmwerte, Bauteile und
nicht bestueckte Bauteile siehe SA.

FOR BINDING INFORMATION ON MODELS,
TRIMMING AND COMPONENTS VALUES AND
NONFITTED COMPONENTS SEE PARTS LIST



ACHTUNG: EGB !
 ELEKTROSTATISCH GEFÄHRDETE
 BAUELEMENTE ERFORDERN EINE
 BESONDERE HANDHABUNG
ATTENTION ESD !
 ELECTROSTATIC SENSITIVE DEVICES
 REQUIRE A SPECIAL HANDLING



		BU	1GPK	DATUM	NAME	BENENNUNG	
			BEARB		SR	DATENSPEICHER_III	
			GEPR.			MEMORY_III	
			NORM			TOP/TOP.1	
			PLOTT	14.11.96	SR	ZEICHN.-NR.	
			ROHDE&SCHWARZ			395.3063.01 S	
			ZU GERAET URV5-27			REG.I.V.	395.2615
						ERSTZ.	000.0000
						BLATT-NR.	
						1 -	
						v BL	

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FÜR DIESE UNTERLAGE
BEHALTEN WIR UNS ALLE RECHTE VOR

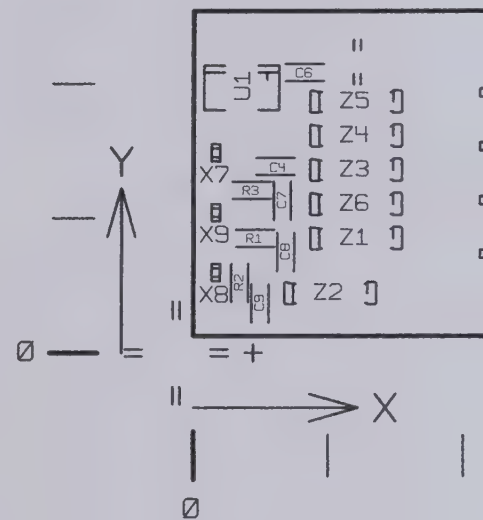
DARSTELLUNG SEITE B
VIEW ON SIDE B

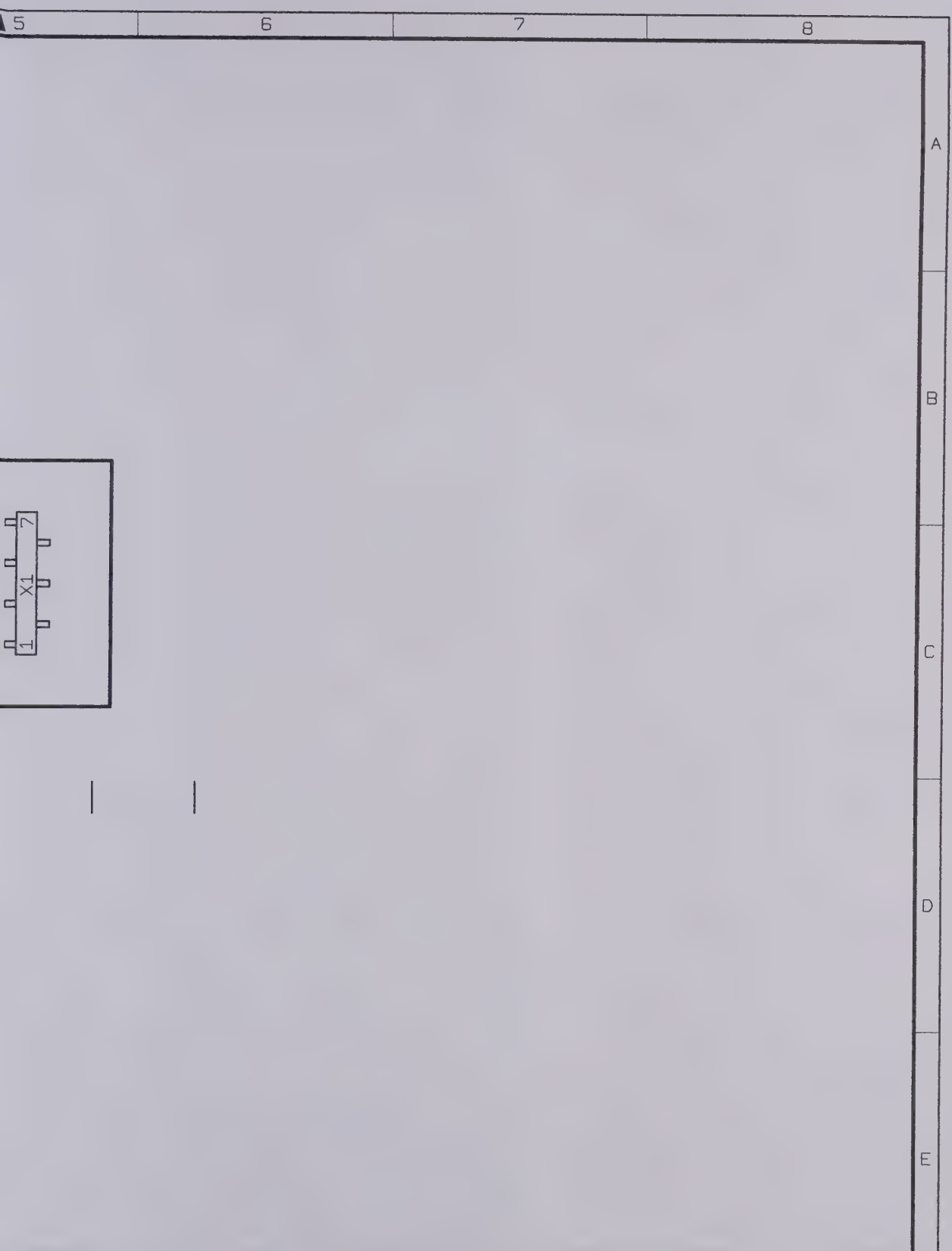


ACHTUNG: EGBI
ELEKTROSTATISCH GEFÄHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG.
ATTENTION ESDI
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING

BINDENDE ANGABEN ÜBER VARIANTEN,
TRIMMWERTE, BAUTEILWERTE UND
NICHT BESTÜCKTE BAUTEILE SIEHE SA.

FOR BINDING INFORMATION ON MODELS,
TRIMMING AND COMPONENTS VALUES AND
NONFITTED COMPONENTS SEE PARTS LIST.





				1GPK	DATUM	NAME	BENENNUNG		
				BEARB.		BU	ANSCHLUSSPLATTE PROBE_BOARD		
				GEPR.		BU			
				NORM					
				PLOTT	24.01.97	BAUR_A			
				ROHDE&SCHWARZ			ZEICHN.-NR.		BLATT-NR.
							828.4250.01 D		1+
END.	AENDERUNGS-	DATUM	NAME	ZU GERAET NRV-Z1			REG.I.V.	828.3018	V. BL.
	MITTEILUNG						ERSTE Z.		

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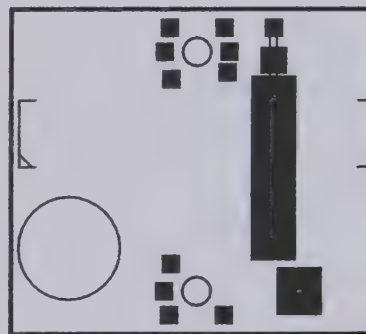
DARSTELLUNG SEITE A
VIEW ON SIDE A



ACHTUNG: EGBI
ELEKTROSTATISCH GEFÄHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG.
ATTENTION ESD!
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING

BINDENDE ANGABEN ÜBER VARIANTEN,
TRIMMWERTE, BAUTEILWERTE UND
NICHT BESTÜCKTE BAUTEILE SIEHE SA.

FOR BINDING INFORMATION ON MODELS,
TRIMMING AND COMPONENTS VALUES AND
NONFITTED COMPONENTS SEE PARTS LIST.

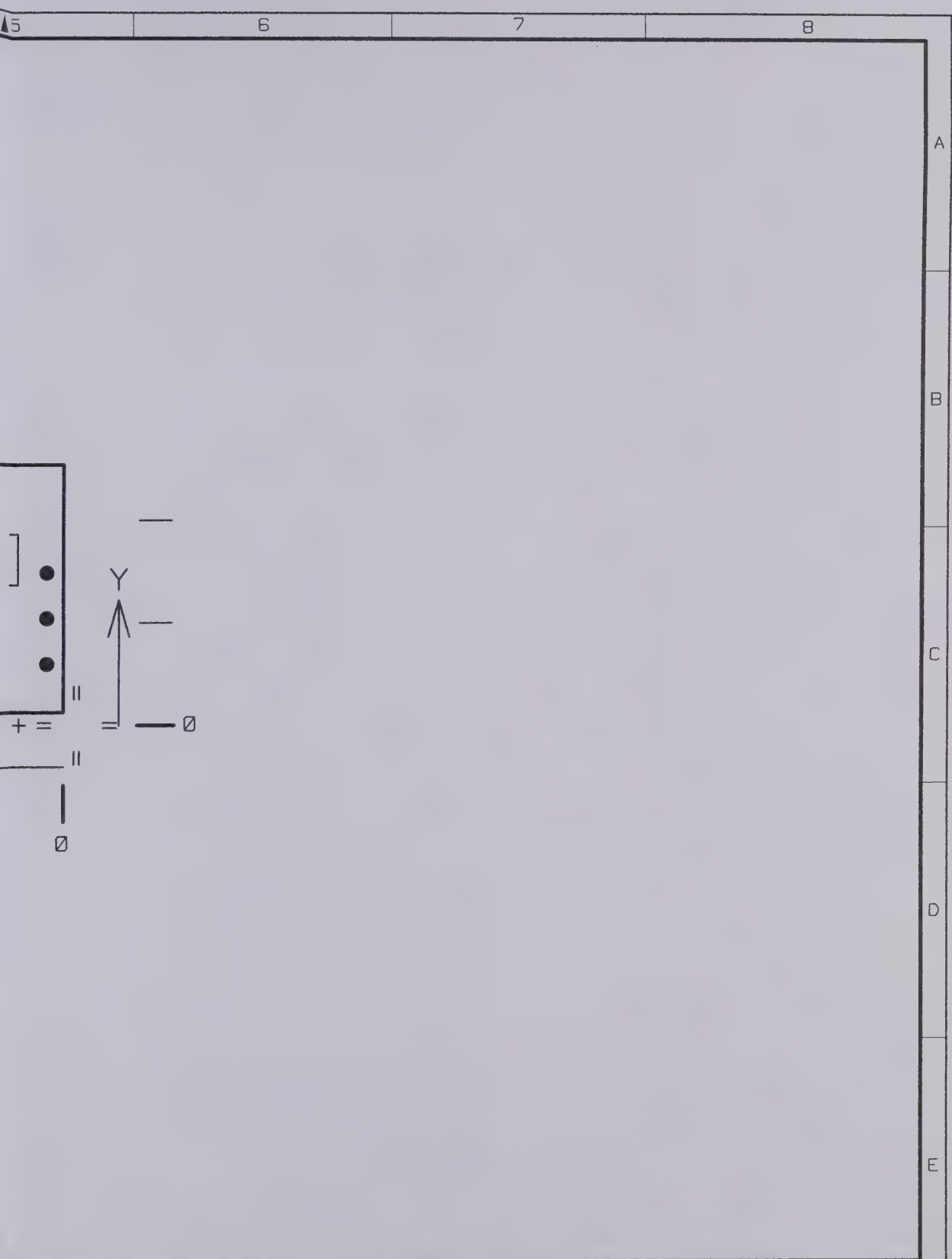


X ←

01

AEN

IND



1GPK		DATUM	NAME	BENENNUNG	
BEARB.			BU	ANSCHLUSSPLATTE PROBE_BOARD	
GEPR.			BU		
NORM					
PLOTT		24.01.97	BAUR_A	ZEICHN.-NR.	
ROHDE&SCHWARZ		ZU GERAET NRV-Z1		828.4250.01 D	
				REG.I.V. 828.3018	
AENDERUNGS- MITTEILUNG		DATUM	NAME	ERSTE Z.	

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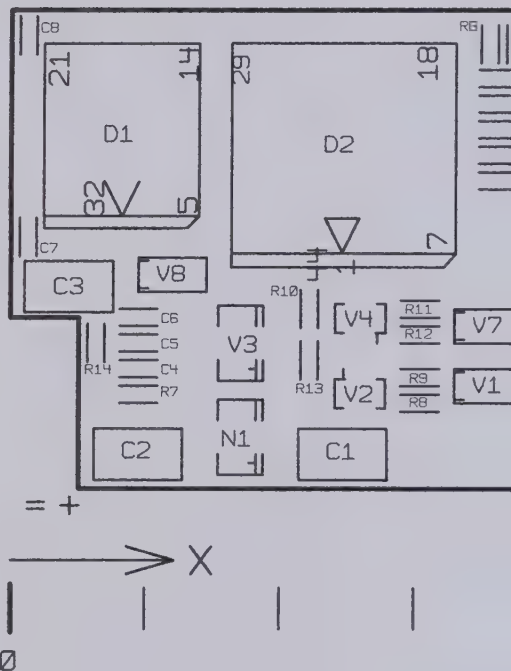
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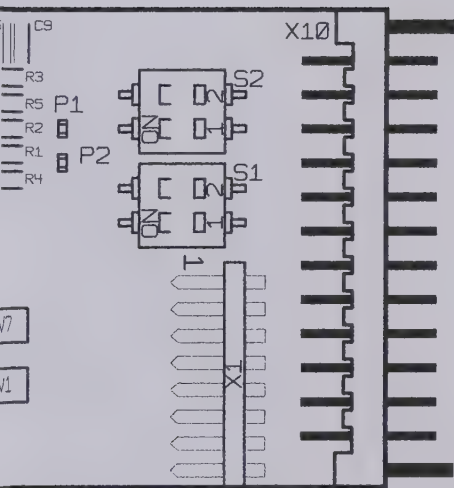
DARSTELLUNG SEITE B
VIEW ON SIDE B



ACHTUNG: EGB!
ELEKTROSTATISCH GEFÄHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG.
ATTENTION ESD!
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING

BINDENDE ANGABEN UEBER VARIANTEN,
TRIMMWERTE, BAUTEILWERTE UND
NICHT BESTUECKTE BAUTEILE SIEHE SA.

FOR BINDING INFORMATION ON MODELS,
TRIMMING AND COMPONENTS VALUES AND
NONFITTED COMPONENTS SEE PARTS LIST.



03				1GPK	DATUM	NAME	BENENNUNG	
				BEARB.		SR	DATENSPEICHER_III	
				GEPR.		SR	MEMORY_III	
				NORM				
				PLOTT	14.11.96	BAUR_A		
02				ROHDE&SCHWARZ			ZEICHN.-NR.	BLATT-NR.
							395.3063.01 D	1+
ÄND.	ÄNDERUNGS-	DATUM	NAME	ZU GERAET URV5-Z7			REG.I.V. 395.2615	V. BL.
IND.	MITTEILUNG						ERSTE Z. 000.0000	

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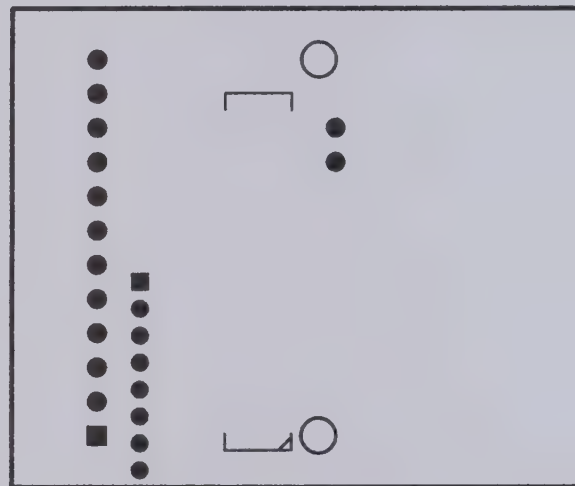
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BEHALTEN WIR UNS ALLE RECHTE VOR



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DARSTELLUNG SEITE A
VIEW ON SIDE A

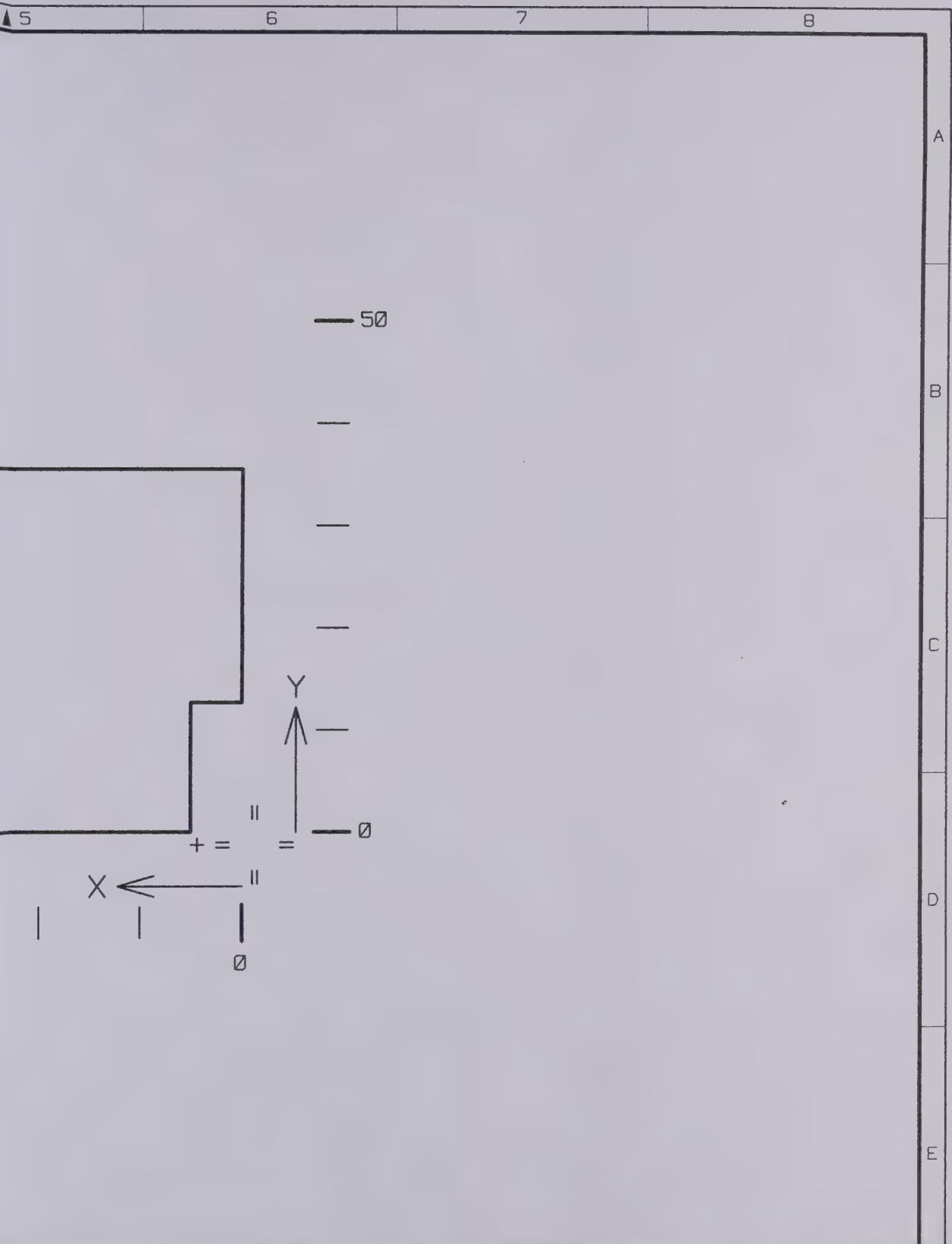


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3				1GPK	DATUM	NAME	BENENNUNG		DATENSPEICHER_III MEMORY_III
				BEARB.		SR			
				GEPR.		SR			
				NORM					
				PLOTT	14.11.96	BAUR_A			
2							ZEICHN.-NR.		BLATT-NR.
							395.3063.01 D		2-
ÄND.	ÄNDERUNGS-			ROHDE&SCHWARZ					V. Bl.
IND.	MITTEILUNG	DATUM	NAME	ZU GERAET URV5-Z7			REG.I.V. 395.2615	ERSTE Z. 000.0000	

5 6 7 8



ROHDE & SCHWARZ

Geschäftsbereich
Meßtechnik

Beschreibung

Thermischer Leistungsmeßkopf

NRV-Z51 (0 ... 18 GHz)

857.9004.02

NRV-Z52 (0 ... 26,5 GHz)

857.9204.02

NRV-Z55 (0 ... 40 GHz)

1081.2005.02

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EU-KONFORMITÄTSERKLÄRUNG



Zertifikat-Nr.: 9502231

Hiermit wird bescheinigt, daß der/die/das:

Gerätetyp	Identnummer	Benennung
NRV-Z1	0828.3018.02/.03	Leistungsmeßkopf
NRV-Z2	0828.3218.02/.03	"
NRV-Z3	0828.3418.02/.03	"
NRV-Z4	0828.3618.02/.03	"
NRV-Z5	0828.3818.02/.03	"
NRV-Z6	0828.5010.02	"
NRV-Z15	1081.2305.02	"
NRV-Z31	0857.9604.02/.03/.04	Spitzenleistungsmeßkopf
NRV-Z32	1031.6807.04/.05	"
NRV-Z33	1031.6507.03/.04	"
NRV-Z51	0857.9004.02	Thermischer Leistungsmeßkopf
NRV-Z52	0857.9204.02	"
NRV-Z53	0858.0500.02	"
NRV-Z54	0858.0800.02	"
NRV-Z55	1081.2005.02	"

mit den Bestimmungen des Rates der Europäischen Union zur Angleichung der Rechtsvorschriften der Mitgliedstaaten

- über die elektromagnetische Verträglichkeit
(89/336/EWG geändert durch 91/263/EWG, 92/31/EWG, 93/68/EWG)

übereinstimmt.

Die Übereinstimmung wird nachgewiesen durch die Einhaltung folgender Normen:

EN50081-1 : 1992
EN50082-1 : 1992

Anbringung des CE-Zeichens ab: 95

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

München, den 26.11.96

Zentrales Qualitätswesen FS-QZ / Becker

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ROHDE & SCHWARZ

Leistungsmeßköpfe **NRV-Z**

für die HF- und Mikrowellentechnik



Der passende Sensor für jede Anwendung

Leistungsmeßköpfe NRV-Z

für die HF- und Mikrowellentechnik



Mit einer umfangreichen Palette von Abschluß-Meßköpfen bietet Rohde & Schwarz das passende Handwerkszeug für alle Leistungsmessungen mit der NRV-Gerätfamilie.

Insgesamt zehn Meßköpfe erschließen den Frequenzbereich von DC bis 26,5 GHz. Mit drei Empfindlichkeitsklassen kann jeder Pegel zwischen 400 pW und 500 mW direkt erfaßt werden. Größere Leistungen bis in den kW-Bereich sind über vorschaltbare Richtkoppler oder Leistungs-Dämpfungsglieder meßbar. Für Fernseh- und Video-Anwendungen steht ein 75- Ω -Sensor zur Verfügung.

Anschließen und messen

Mit den individuell kalibrierten Abschluß-Meßköpfen der NRV-Familie ist präzise Leistungsmessung keine Zeitfrage. Der integrierte Kalibrierdatenspeicher enthält alle relevanten Informationen und entlastet den Anwender von fehlerträchtigen und zeitaufwendigen Nebenaufgaben. Die regelmäßige Nachkalibrierung des Grundgeräts nach einer Temperaturänderung oder dem Wechsel des

Meßkopfes entfällt ebenso wie das Ablesen und Eintippen von Korrekturfaktoren. Unmittelbar nach dem Anstecken eines Meßkopfes steht ein vollständig kalibriertes Leistungsmeßgerät zur Verfügung. Neben den meßtechnisch erforderlichen Daten enthält der Kalibrierdatenspeicher auch Informationen, die die Bedienung vereinfachen: Statt mit Bereichsnummern zu hantieren, die einmal 100 nW und ein anderes Mal 1 mW bedeuten können, kann der Anwender von NRVD und NRVS alle Meßbereiche im Klartext anwählen.

Der thermische Sensor im Meßkopf NRV-Z51: Präzision in Halbleiter- und Dünnschichttechnologie

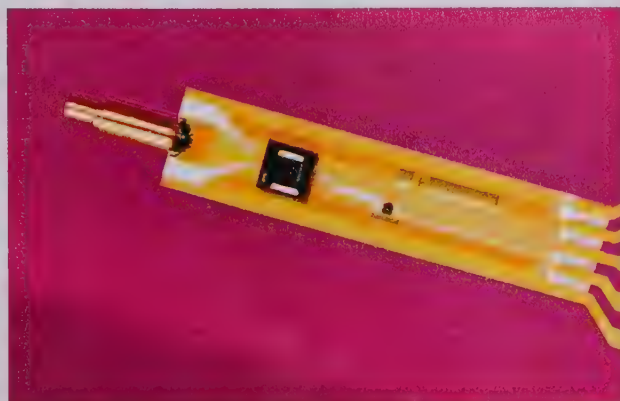
DC...26,5 GHz
400 pW...0,5 W

Der passende Sensor für jede Anwendung

Abschluß-Meßköpfe absorbieren die zugeführte HF-Leistung und stellen an ihrem Ausgang eine äquivalente Gleichstrom-Meßgröße zur Verfügung. Um den Leistungsbereich von unter 1 nW bis über 100 mW zu erfassen, sind zwei verschiedene Typen von Leistungs-Sensoren erforderlich: thermoelektrische Sensoren, basierend auf dem Seebeck-Effekt, und Halbleiter-Detektoren mit Zero-Bias-Schottky-Dioden neuester Technologie. Beide Wandlertypen sind für das gesamte Frequenzspektrum lieferbar.

Thermische Sensoren, wie NRV-Z51, erschließen den Leistungsbereich von 1 μ W bis 100 mW. Sie zeigen unabhängig von der Signalform immer die mittlere Leistung an. Durch individuelle Kalibrierung sind die thermischen Meßköpfe von Rohde & Schwarz konkurrenzlos linear, und zwar über den gesamten Dynamikbereich.

Zum Messen kleinster Leistungen von 0,4 nW bis 10 μ W sind **hochempfindliche Sensoren** auf der Basis von Dioden-Detektoren, wie NRV-Z4, unverzichtbar. Sie messen in dem



angegebenen Leistungsbereich ebenfalls effektivwertrichtig und dürfen ohne weiteres für oberwellenhaltige, verrauschte oder modulierte Signale verwendet werden.

Empfindliche Sensoren auf der Basis von Dioden-Detektoren mit 20-dB-Vorteiler, wie NRV-Z5, schließen die Lücke zwischen den hochempfindlichen und den thermischen Sensoren. Durch hervorragende Anpassung und kurze Meßzeiten sind sie die optimalen Meßköpfe im Leistungsbereich von 1 μ W bis 1 mW. Über den genannten Bereich messen diese Sensoren außerdem effektivwertrichtig.



Die Kalibrierung der NRV-Meßköpfe ist direkt auf die Normalen der Physikalisch-Technischen Bundesanstalt rückführbar

Alle Diodenmeßköpfe können bei verhältnismäßig spektralreinen Signalen weit über den Effektivwert-Bereich hinaus verwendet werden: die hochempfindlichen Sensoren bis etwa 20 mW und die empfindlichen Meßköpfe bis 0,5 W. Durch den außerordentlich großen Dynamikbereich sind diese Sensoren besonders für Reflexions- und Dämpfungsmessungen geeignet. Bei Systemanwendungen besteht die hohe Meßgeschwindigkeit bei größeren Leistungen.

Präzise Kalibrierung

Jeder NRV-Meßkopf enthält im integrierten Datenspeicher alle meßtechnisch relevanten Informationen. Der Zusammenhang zwischen der Meßgröße Leistung und dem Sensor-Ausgangssignal wird über frequenzabhängige Kalibrierfaktoren hergestellt.

Deren präzise Ermittlung ist nur mit Spezialmeßgeräten möglich. Zur Erhöhung der Meßgenauigkeit werden die entsprechenden Standards direkt an die Primärnormale der Physikalisch-Technischen Bundesanstalt (PTB) angeschlossen.

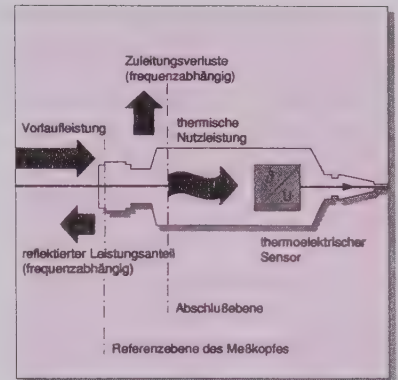
Trotzdem entstehen bei der Ermittlung der Kalibrierfaktoren verschiedene Meßfehler. Die einzelnen Komponenten werden nach statistischen Gesetzmäßigkeiten zusammengefaßt und als RSS-Kalibrierunsicherheit mit einem Vertrauensbereich von etwa 95% in den technischen Daten spezifiziert.

Die Kalibrierfaktoren sind für alle Meßköpfe so definiert, daß damit die dem Sensor zugeführte Leistung, die Vorlaufeistung, angezeigt wird. Leistungsverluste durch Reflexion sind darin ebenso berücksichtigt wie die Absorption von HF-Energie zwischen der Referenzebene des Anschlußsteckers und dem Sensor (siehe Bild rechts).

Alle Leistungsmesser der NRV-Gerätefamilie suchen nach Eingabe der Meßfrequenz selbsttätig den passenden Kalibrierfaktor im Datenspeicher und korrigieren damit die angezeigte Leistung.

Hervorragend angepaßt

Die Leistungsmeßköpfe NRV-Z sind hervorragend angepaßt. Kleines VSWR über den ganzen Frequenzbereich führt zu vergleichsweise geringen Anpaßfehlern. Trotzdem ist

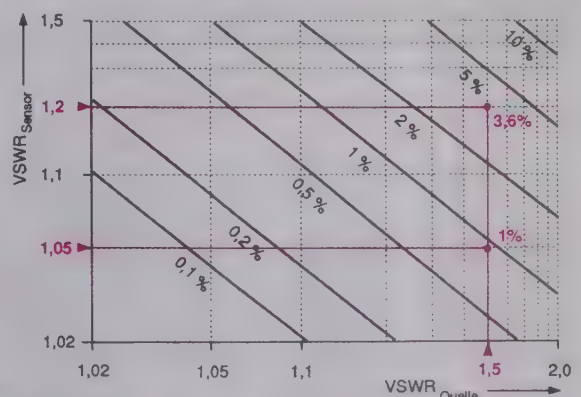


Leistungsmesser werden auf die Vorlaufeistung kalibriert; die Abbildung zeigt den Leistungsfluß am Beispiel eines thermischen Meßkopfes

Fehlanpassung häufig der größte Unsicherheitsfaktor bei Leistungsmessungen. Insbesondere schlecht angepaßte Quellen liefern an den Meßkopf nicht die Nennleistung, sondern deutlich mehr oder auch weniger, wenn sie mit zurückfließender Leistung beaufschlagt werden. Je besser der Meßkopf angepaßt ist, umso geringer ist diese Form der Rückwirkung. Die Grenzwerte des möglichen Meßfehlers sind dem Diagramm unten zu entnehmen.

Beispiel: Leistungsmessung an einer Quelle mit $VSWR = 1,5$: Ein sehr gut angepaßter Meßkopf mit einem VSWR von 1,05 führt zu einer Fehlanpassungs-Unsicherheit von nur 1%, während bei schlechter angepaßtem Meßkopf ($VSWR = 1,2$) mit 3,6% gerechnet werden muß (rote Kurve).

Meßunsicherheit
(in Prozent der Leistung) durch Fehlanpassung von Quelle und Meßkopf
(rot: Beispiel im Text)



Grundgeräte

Insgesamt sechs Geräte stehen für die Leistungsmessung mit NRV-Meßköpfen zur Verfügung.

NRVD Moderner Zweikanal-Leistungsmesser mit Menü-Bedienung und schnellem IEC-Bus-Anschluß (SCPI). Besonders geeignet für Relativmessungen mit zwei Meßkanälen (Dämpfung, Reflexion). Umfangreiche Palette von Meßfunktionen, Meßwertdarstellung in allen üblichen Einheiten. Viele Extras, wie 1-mW-Testgenerator, Anzeige der Meßunsicherheit usw. Alle Meßköpfe anschließbar.

NRVS Preiswerter Einkanal-Leistungsmesser, Bedienung wie NRVD. Viele Meßfunktionen, Meßwertdarstellung in allen üblichen Einheiten, Analogausgang serienmäßig. IEC-Bus-Anschluß, syntaxkompatibel zu NRV/URV 5. Alle Meßköpfe anschließbar.

NRV Bewährter Zweikanal-Leistungsmesser für Labor- und Systemeinsatz. Viele Meßfunktionen, Meßergebnisdarstellung in allen üblichen Einheiten, IEC-Bus-Anschluß. Bis auf NRV-Z51/Z52 alle Meßköpfe anschließbar.

URV 35 Kompaktes Spannungs- und Leistungsmeßgerät für Service, Prüffeld und Labor. Einzigartige Kombination von Analog- und Digitalanzeige durch Drehspulinstrument mit hinterlegtem LC-Display. Viele Meßfunktionen, Anzeige in allen üblichen Einheiten, wahlweise Batterie- oder Netzbetrieb, RS-232-Schnittstelle. Alle Meßköpfe anschließbar.

URV 55 Preiswerter Einkanal-Spannungsmesser, ähnlich dem NRVS. Alle Meßköpfe anschließbar.

URV 5 Zweikanal-Spannungsmesser, ähnlich NRV. Bis auf NRV-Z51/Z52 alle Meßköpfe anschließbar.

Meßköpfe zur Spannungs- und Pegelmessung

Mit Tast- und Durchgangsköpfen (Datenblatt PD 756.9816) ergeben sich weitere interessante Anwendungen für die Leistungsmesser der NRV-Familie:

HF-Tastkopf URV 5-Z7

Für nahezu rückwirkungsfreies Messen in offenen HF-Schaltungen bis 400 MHz. Umfangreiches Zubehör, u.a. Adapter für 50- und 75- Ω -Anschlüsse.

DC-Probe URV 5-Z1

Für belastungsarme Gleichspannungsmessungen in HF-Schaltungen von 1 mV bis 400 V.

Durchgangsköpfe URV 5-Z2/Z4

Zur Pegelmessung zwischen Quelle und Verbraucher in koaxialen 50- und 75- Ω -Systemen. Bei gut angepaßter Last sind damit Durchgangsleistungsmessungen von -60 bis +53 dBm ohne Richtkoppler möglich. Frequenzbereich von 9 kHz bis 2 GHz.

Doppel-Richtkoppler URV 5-Z9

Für Durchgangsleistungs- und Reflexionsmessungen in Verbindung mit zwei HF-Tastköpfen URV 5-Z7. Frequenzbereich von 100 kHz bis 80 MHz, Leistungmeßbereich 10 μ W bis 2 kW.

NRVD



URV 35



NRVS



URV 55



NRV



URV 5



Hochempfindliche Sensoren

Effektivbewertung bis 10 μ W

Modell	Frequenzbereich	Leistungsbereich Belastbarkeit	VSWR (Reflexionsfaktor)	Nullpunkt- fehler ($\pm$) ¹⁾	Anzeige- rauschen 2σ ²⁾	Linearitäts- fehler ($\pm$) ³⁾	Anschluß
NRV-Z4	100 kHz...6 GHz	500 pW...20 mW 100 mW (avg) 100 mW (pk)	0,1...100 MHz: 1,05 (0,024) 0,1...2 GHz: 1,1 (0,048) 2...4 GHz: 1,2 (0,09) 4...6 GHz: 1,35 (0,15)	50 pW	20 pW	0,4 %	N
NRV-Z7	10 MHz...13 GHz	1 nW...20 mW 100 mW (avg) 100 mW (pk)	0,01...1 GHz: 1,06 (0,03) 1...2 GHz: 1,13 (0,06) 2...4 GHz: 1,27 (0,12) 4...13 GHz: 1,41 (0,17)	100 pW	40 pW	0,4 %	N
NRV-Z1	10 MHz...18 GHz	1 nW...20 mW 100 mW (avg) 100 mW (pk)	0,01...1 GHz: 1,06 (0,03) 1...2 GHz: 1,13 (0,06) 2...4 GHz: 1,27 (0,12) 4...18 GHz: 1,41 (0,17)	100 pW	40 pW	0,4 %	N
NRV-Z6	50 MHz...26,5 GHz	1 nW...20 mW 100 mW (avg) 100 mW (pk)	0,05...0,1 GHz: 1,3 (0,13) 0,1...18 GHz: 1,2 (0,09) 18...26,5 GHz: 1,4 (0,165)	200 pW	80 pW	0,5 %	PC 3,5
NRV-Z3 75 Ω	1 MHz...2,5 GHz	400 pW...13 mW 70 mW (avg) 70 mW (pk)	0,001...1 GHz: 1,11 (0,05) 1...2,5 GHz: 1,2 (0,09)	40 pW	16 pW	0,4 %	N

Empfindliche Sensoren

Effektivbewertung bis 1 mW

Modell	Frequenzbereich	Leistungsbereich Belastbarkeit	VSWR (Reflexionsfaktor)	Nullpunkt- fehler ($\pm$) ¹⁾	Anzeige- rauschen 2σ ²⁾	Linearitäts- fehler ($\pm$) ³⁾	Anschluß
NRV-Z5	100 kHz...6 GHz	50 nW...500 mW 2 W (avg) 10 W (pk)	100 kHz...4 GHz: 1,05 (0,024) 4...6 GHz: 1,1 (0,048)	5 nW	2 nW	0,3 %	N
NRV-Z8	10 MHz...13 GHz	100 nW...500 mW 2 W (avg) 10 W (pk)	0,01...4 GHz: 1,05 (0,024) 4...8 GHz: 1,1 (0,048) 8...13 GHz: 1,15 (0,07)	10 nW	4 nW	0,3 %	N
NRV-Z2	10 MHz...18 GHz	100 nW...500 mW 2 W (avg) 10 W (pk)	0,01...4 GHz: 1,05 (0,024) 4...8 GHz: 1,1 (0,048) 8...12,4 GHz: 1,15 (0,07) 12,4...18 GHz: 1,2 (0,09)	10 nW	4 nW	0,3 %	N

Thermische Sensoren

Effektivbewertung im gesamten Leistungsbereich

Modell	Frequenzbereich	Leistungsbereich Belastbarkeit	VSWR (Reflexionsfaktor)	Nullpunkt- fehler ($\pm$) ¹⁾	Anzeige- rauschen 2σ ²⁾	Linearitäts- fehler ($\pm$) ³⁾	Anschluß
NRV-Z51	DC...18 GHz	1 μ W...100 mW 300 mW (avg) 10 W (pk, 1 μ s)	DC...2 GHz: 1,1 (0,048) 2...12,4 GHz: 1,15 (0,07) 12,4...18 GHz: 1,2 (0,09)	60 nW	22 nW	0,6 %	N
NRV-Z52	DC...26,5 GHz	1 μ W...100 mW 300 mW (avg) 10 W (pk, 1 μ s)	DC...2 GHz: 1,1 (0,048) 2...12,4 GHz: 1,15 (0,07) 12,4...18 GHz: 1,2 (0,09) 18...26,5 GHz: 1,25 (0,11)	60 nW	22 nW	0,6 %	PC 3,5

Kalibrierunsicherheiten

RSS in %, bezogen auf angezeigte Leistung

Frequenz (MHz)	NRV-Z3	NRV-Z4	NRV-Z5
0,1		0,8	0,8
0,15		0,8	0,8
0,2		0,8	0,8
0,455		0,8	0,8
1	1,1	0,8	0,8
1,25	1,1	-	-
3	1,1	-	-
10	1,1	0,8	0,8
30	1,1	-	-
50	1,1	0,8	0,8
100	1,1	0,8	0,8
500	1,6	1,5	1,4
1000	1,6	1,5	1,4
1200	2,0	-	-
1400	2,0	-	-
1500	-	1,5	1,4
1600	2,0	-	-
1800	2,0	-	-
2000	2,0	1,5	1,4
2200	2,0	-	-
2300	2,0	-	-
2400	2,0	-	-
2500	2,0	1,8	1,7
3000	-	1,8	1,7
3200	-	1,8	1,7
3400	-	1,8	1,7
3600	-	1,8	1,7
3800	-	1,8	1,7
4000	-	1,8	1,7
4200	-	2,2	1,9
4400	-	2,2	1,9
4600	-	2,2	1,9
4800	-	2,2	1,9
5000	-	2,2	1,9
5200	-	2,2	1,9
5400	-	2,2	1,9
5600	-	2,2	1,9
5800	-	2,2	1,9
6000	-	2,2	1,9

Frequenz (GHz)	NRV-Z1/Z7 ⁴⁾	NRV-Z2/Z8 ⁴⁾	NRV-Z51	NRV-Z6	NRV-Z52
0,01	1,6	0,8	0,6	-	0,7
0,05	1,6	0,8	0,6	1,3	0,7
0,1	1,6	0,8	0,6	1,3	0,7
0,5	2,1	1,5	0,8	1,3	1,0
1	2,1	1,5	0,8	1,3	1,0
1,5	2,1	1,5	-	-	-
2	2,1	1,5	0,8	1,3	1,0
2,5	2,6	1,8	-	-	-
3	2,6	1,8	1,3	1,8	1,6
3,5	2,6	1,8	-	-	-
4	2,6	1,8	1,3	1,8	1,6
4,4	3,8	2,0	-	-	-
5	3,8	2,0	1,3	1,8	1,6
5,4	3,8	2,0	-	-	-
6	3,8	2,0	1,3	1,8	1,6
6,4	3,8	2,0	-	-	-
7	3,8	2,0	1,3	1,8	1,6
7,4	3,8	2,0	-	-	-
8	3,8	2,0	1,3	1,8	1,6
8,4	4,0	2,8	-	-	-
9	4,0	2,8	1,9	2,9	2,5
9,4	4,0	2,8	-	-	-
10	4,0	2,8	1,9	2,9	2,5
10,4	4,0	2,8	-	-	-
11	4,0	2,8	1,9	2,9	2,5
11,4	4,0	2,8	-	-	-
12	4,0	2,8	1,9	2,9	2,5
12,4	4,0	2,8	1,9	2,9	2,5
13	4,0	2,8	2,5	3,2	3,1
13,5	5,6	3,3	-	-	-
14	5,6	3,3	2,5	3,2	3,1
14,5	5,6	3,3	-	-	-
15	5,6	3,3	2,5	3,2	3,1
15,5	5,6	3,3	-	-	-
16	5,6	3,3	2,5	3,2	3,1
16,5	5,6	3,3	-	-	-
17	5,6	3,3	2,5	3,2	3,1
17,5	5,6	3,3	-	-	-
18	5,6	3,3	2,5	3,2	3,1
19	-	-	-	2,8	2,5
20	-	-	-	2,8	2,5
21	-	-	-	2,8	2,5
22	-	-	-	2,8	2,5
23	-	-	-	2,8	2,5
24	-	-	-	2,8	2,5
25	-	-	-	2,8	2,5
26	-	-	-	2,8	2,5
26,5	-	-	-	2,8	2,5

Temperatureinfluß

In %, bezogen auf angezeigte Leistung (typische Werte in Klammern)

	22...24 °C	18...28 °C	10...40 °C	0...50 °C
NRV-Z1...Z8	0 ⁵⁾	1,0 (0,3)	3,0 (1)	7,0 (2)
NRV-Z51/Z52	0 ⁵⁾	0,4 (0,1)	1,3 (0,4)	2,0 (0,5)

Gesamtbetrachtung

Zur Berechnung der Gesamtunsicherheit der an Z₀ verfügbaren

Leistung der Quelle sind folgende Komponenten zu berücksichtigen:

Fehlanspassungsunsicherheit (siehe Diagramm)

Kalibrierunsicherheit, Linearitätsfehler bei 23 °C

Linearitäts-Zusatzfehler³⁾ (nur Diodenmeßköpfe außerhalb des Effektivwert-Bereichs)

Anzeigeräuschen, Nullpunktfehler, Temperatureinfluß

Grundgerätefehler (siehe Spezifikationen NRVs, NRVD, NRV)



Allgemeine Daten

Betriebstemperaturbereich 0...+50 °C, Einsatzklasse 1 nach IEC 359 (keine Betaung)
 Lagertemperaturbereich -40...+70 °C
 Abmessungen, Gewicht 120 mm x 37 mm x 31 mm, 0,35 kg
 Länge des Anschlußkabels etwa 1,3 m; andere Längen auf Anfrage

Bestellbezeichnungen

Leistungsmeßkopf 20 mW, 50 Ω, 18 GHz . . . NRV-Z1 828.3018.02
 Leistungsmeßkopf 500 mW, 50 Ω, 18 GHz . . . NRV-Z2 828.3218.02
 Leistungsmeßkopf 13 mW, 75 Ω, 2,5 GHz . . . NRV-Z3 828.3418.02
 Leistungsmeßkopf 20 mW, 50 Ω, 6 GHz . . . NRV-Z4 828.3618.02
 Leistungsmeßkopf 500 mW, 50 Ω, 6 GHz . . . NRV-Z5 828.3818.02
 Leistungsmeßkopf 20 mW, 50 Ω, 26,5 GHz . . . NRV-Z6 828.5010.02
 Leistungsmeßkopf 20 mW, 50 Ω, 13 GHz . . . NRV-Z7 828.5210.02
 Leistungsmeßkopf 500 mW, 50 Ω, 13 GHz . . . NRV-Z8 828.5410.02
 Leistungsmeßkopf 100 mW, 50 Ω, 18 GHz . . . NRV-Z51 857.9004.02
 Leistungsmeßkopf 100 mW, 50 Ω, 26,5 GHz . . . NRV-Z52 857.9204.02

- 1) Innerhalb 1 h nach Nullabgleich, zulässige Temperaturänderung 1 °C, Grundgerät 2 h eingelaufen.
 2) Die Rauschangaben (2 Standardabweichungen) beziehen sich auf Filter 11, Temperatur 18...28 °C. Filter 11 stellt sich bei NRVS und NRVD automatisch im empfindlichsten Meßbereich ein (Auto-Filter-Modus, Auflösung HIGH). Die Rauschwerte für andere Filtereinstellungen ergeben sich durch Multiplikation mit den tabellierten Faktoren.

Filter-Nr.	NRVS/NRVD	0	1	2	3	4	5	6	7	8	9	10	11	12
	URV5/NRV	F5			F4		F3		F2		F1		F0	
Rausch-Multiplikator		51	32	23	16	11,3	8	5,6	4	2,8	2	1,4	1,0	0,7
Meß-zeit/s	NRV-Z1...Z8	0,045	0,05	0,06	0,08	0,15	0,27	0,49	0,95	1,85	3,6	7,2	14,5	28,5
	NRV-Z51/Z52	0,115	0,12	0,13	0,15	0,21	0,32	0,52	0,92	1,75	3,4	6,6	13	26

Die angegebenen Meßzeiten sind Richtwerte für den ferngesteuerten Betrieb. Genaue Werte sind den technischen Daten von NRVS, NRVD und NRV zu entnehmen

- 3) Linearität, bezogen auf die Kalibrierleistung von 10 µW für die hochempfindlichen, 1 mW für die empfindlichen und 1,6 mW für die thermischen Sensoren
 Alle Dioden-Meßköpfe können für sinusförmige, unmodulierte Signale weit außerhalb des Effektivwert-Bereichs verwendet werden. Dabei sind größere Linearitätsfehler möglich:
 a) außerhalb des Temperaturbereichs 23 ± 2 °C (nur relevant für Relativmessungen; für die Berechnung der Gesamtunsicherheit unerheblich, da bereits im Temperatureinfluß berücksichtigt).
 b) in den nachstehend aufgeführten Frequenz- und Leistungsbereichen (Linearitäts-Zusatzfehler). Die angegebenen Werte sind bei der Berechnung der Gesamtunsicherheit und bei Relativmessungen zu berücksichtigen.

NRV-Z4	1,5...3 GHz:	+2 % (0,02...2 mW), +4 % (2...20 mW)	NRV-Z5	1,5...3 GHz:	+2 % (2...200 mW), +3,5 % (0,2...0,5 W)
	3...6 GHz:	+6 % (0,02...2 mW), +10 % (2...20 mW)		3...6 GHz:	+6 % (2...200 mW), +8 % (0,2...0,5 W)
NRV-Z1/Z7	4...8 GHz:	+2 % (0,02...2 mW), +4 % (2...20 mW)	NRV-Z2/Z8	4...8 GHz:	+2 % (2...200 mW), +3,5 % (0,2...0,5 W)
	8...13 GHz:	+5 % (0,02...2 mW), +10 % (2...20 mW)		8...13 GHz:	+5 % (2...200 mW), +8 % (0,2...0,5 W)
	13...18 GHz:	+6 % (0,02...2 mW), +12 % (2...20 mW)		13...18 GHz:	+6 % (2...200 mW), +10 % (0,2...0,5 W)
NRV-Z6	0,05...0,2 GHz:	-2,5/+0,5 % (0,02...2 mW), -4,5/+1,5 % (2...20 mW)			
	0,2...14 GHz:	±0,5 % (0,02...2 mW), ±1,5 % (2...20 mW)			
	14...26,5 GHz:	-0,5/+1,5 % (0,02...2 mW), -0,5/+4,5 % (2...20 mW)			
NRV-Z3	ohne Zusatzfehler				

- 4) Die Meßköpfe NRV-Z7/Z8 sind nur bis 13 GHz kalibriert.
 5) In der Kalibrierunsicherheit enthalten.



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Daten ohne Toleranz: nur Größenordnung

PD 756.9797.11

392 (U we)

40-GHz Power Sensors

NRV-Z55

NRV-Z15

Technical Information

Subject to change 4/97-1GP3-Rei

40-GHz Power Sensors NRV-Z55, NRV-Z15

Technical Information

R&S 40-GHz Power Sensors

Rohde & Schwarz is continuously expanding its line of precision power sensors for the NRVS, NRVD, URV35 and URV55 power and level meters. The new Thermal Power Sensor NRV-Z55 offers all the benefits of the thermoelectric principle (1 μ W to 100 mW) together with an outstanding SWR and an ultrawide frequency range from DC to 40 GHz. The new Diode Power Sensor NRV-Z15 from 50 MHz to 40 GHz expands the power measurement range down to 1 nW, with true-rms response up to 10 μ W. Between 10 μ W and 20 mW it should be used for CW signals and all applications where speed counts. Since both sensors come fully calibrated, there is no need for manual calibration upon plugging onto the basic unit or due to temperature changes. It is this feature that makes them the right choice for universal use. Together with the battery-operated URV35 they ensure rapid and precise on-site

measurements. They are suitable for use on NRVS and NRVD in the laboratory or production line.

Best SWR in industry

No other 40-GHz power sensor with K (2.92 mm) connector offers the excellent SWR of NRV-Z55. Especially in the microwave range, where DUTs are normally highly reflective, a well-matched power sensor is the key to reliable measurements. For illustration, let us assume an output with 2.0 source SWR and that its power is measured into 50 Ω at 1.60 sensor SWR which is typical of many 40-GHz power sensors. Mismatch will be the most dominant source of error and contribute as much as 0.67 dB to the overall measurement uncertainty. NRV-Z55 will cut this value by half.

Accurate calibration and traceability

Each Power Sensor of the NRV-Z series is individually cali-

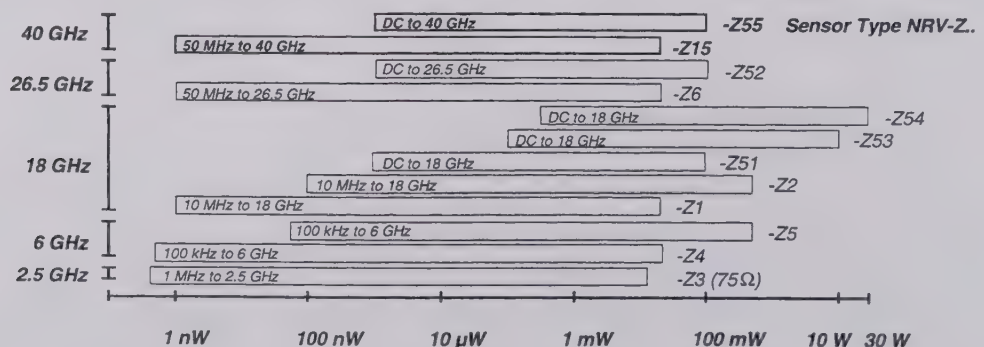
brated with high accuracy so that residual uncertainties often can be neglected. Absolute accuracy is maintained at the highest possible level. For this purpose all power references used in production of the sensors are directly calibrated to the national standards of the Federal German Bureau of Standards (PTB), ensuring minimum loss of accuracy due to transfer of power.

K (2.92 mm) connector for universal use

Both 40-GHz power sensors come with the popular K connector that ensures compatibility with PC3.5 and SMA interfaces, reducing the risk of damage to the connector while maintaining good accuracy without the use of adapters.

All in all the new 40-GHz power sensors are precise, extremely easy-to-operate and highly cost-effective units: plug in the sensors, and they are all ready for your measurement.

Full line of R&S average and CW power sensors



40-GHz Power Sensors NRV-Z55, NRV-Z15

Technical Information

Specifications	NRV-Z55	NRV-Z15
Power meas. range	1 μ W to 100 mW	1 nW to 20 mW
Max. power	300 mW (avg), 10 W (peak, 1 μ s)	100 mW (avg) 100 mW (peak)
Frequency range	DC to 40 GHz	50 MHz to 40 GHz
Impedance	50 Ω	
Max. SWR (reflection coefficient)		
DC to 2 GHz	1.10 (0.048)	1.15 (0.070)
2 to 4 GHz	1.15 (0.070)	1.15 (0.070)
4 to 12.4 GHz	1.15 (0.070)	1.37 (0.157)
12.4 to 18 GHz	1.20 (0.091)	1.37 (0.157)
18 to 26.5 GHz	1.25 (0.111)	1.37 (0.157)
26.5 to 40 GHz	1.30 (0.130)	1.37 (0.157)
Calibration uncertainty ¹		
0.05 to 2 GHz ²	1.2 %	1.5 %
3 to 4 GHz	1.7 %	1.8 %
5 to 12.4 GHz	2.7 %	4.0 %
13 to 18 GHz	3.5 %	4.4 %
19 to 26.5 GHz	2.7 %	3.1 %
27 to 34 GHz	2.4 %	2.7 %
35 to 40 GHz	2.4 %	2.5 %
Zero offset ³	$\pm$ 60 nW	$\pm$ 200 pW
Meter noise ⁴	22 nW	80 pW
Nonlinearity ⁵	$\pm$ 0.5 %	$\pm$ 0.5 %
Temperature effect ⁶		
22 to 24°C	0% ⁷	0% ⁷
18 to 28°C	0.4 (0.1)%	0.6 (0.1)%
10 to 40°C	1.3 (0.4)%	2.0 (0.5)%
0 to 50°C	2.0 (0.5)%	4.0 (1.0)%
RF connector	K (2.92 mm) male	
Temperature range	0°C to +50°C (operating), -40°C to 70°C (storage)	
Other environmental specifications	see URV35, URV55, NRVS and NRVD data sheets	
Dimensions	120 mm x 37 mm x 31 mm	
Weight	0.35 kg	
Length of connecting cable	1.3 m (other lengths on request)	
Order designation	Thermal Power Sensor	NRV-Z55 1081.2005.02
	Diode Power Sensor	NRV-Z15 1081.2305.02

1 Eigenschaften

1.1 Anwendung

Die Leistungsmeßköpfe NRV-Z51, NRV-Z52 und NRV-Z55 sind thermische Meßköpfe zu den Grundgeräten NRVS, NRVD, URV35 und URV55. Sie ermöglichen Leistungsmessungen von 1 μ W bis 100 mW im Frequenzbereich DC ... 18 GHz (NRV-Z51), DC ... 26,5 GHz (NRV-Z52) oder DC ... 40 GHz (NRV-Z55) in Systemen mit 50 Ω Wellenwiderstand.

Das thermische Wandlungsprinzip ermöglicht, unabhängig von Kurvenform und Modulation des Meßsignals, immer effektivwertrichtige Messungen. Je nachdem, ob das Meßergebnis als Leistung bzw. Leistungspegel oder als Spannung ausgegeben wird, erhält man die Anzeige der mittleren Leistung (bzw. des äquivalenten Leistungspegels) oder des Effektivwerts der Spannung.

Alle Meßköpfe sind gleichstromgekoppelt, so daß auch Leistungen im Niederfrequenzbereich gemessen werden können.

1.2 Aufbau und Arbeitsweise

Der Leistungssensor enthält einen in Halbleitertechnologie gefertigten thermoelektrischen Wandler. Durch die zugeführte Leistung erwärmt sich der darauf befindliche 50- Ω -Abschlußwiderstand. Ein eng benachbartes Thermoelement erzeugt eine der Erwärmung proportionale Gleichspannung. Da Abschlußwiderstand und Thermoelement galvanisch getrennt sind, enthalten die Meßköpfe keine Koppelkondensatoren. Dadurch können auch Gleichstromleistungen gemessen werden, und es gibt keine untere Grenzfrequenz, unterhalb derer Anpassung und Frequenzgang wieder schlechter werden.

Die vom Thermoelement erzeugte Gleichspannung wird von einem hochempfindlichen und rauscharmen Verstärker innerhalb des Meßkopfes verstärkt und dem Grundgerät zur weiteren Verarbeitung zugeführt.

Alle Meßköpfe enthalten einen Datenspeicher, in dem die bei der Kalibrierung gewonnenen Kennwerte nichtflüchtig gespeichert sind. Das Grundgerät liest diese Daten aus und berücksichtigt sie bei der Anzeige des Meßergebnisses.

Die Linearitätskorrektur der Meßwerte erfolgt automatisch anhand der gespeicherten Korrekturfaktoren. Zur Temperaturkompensation wird zusätzlich die Temperatur des Meßkopfes über einen Temperatursensor ausgewertet. Für frequenzgangkorrigierte Messungen muß über Tastatur, Fernsteuerschnittstelle oder einen analogen Steuereingang die Meßfrequenz eingegeben werden.

2 Betriebsvorbereitung

Die Verbindung des Meßkopfes mit dem Grundgerät erfolgt durch Einstecken des Steckadapters in den Schacht des Grundgerätes bis zum mechanischen Rastpunkt. Dies kann im aus- oder eingeschalteten Zustand erfolgen. Jedes Einschalten des Grundgerätes mit angestecktem Meßkopf oder das Anstecken des Meßkopfes an ein eingeschaltetes Grundgerät bewirkt das Auslesen der Kalibrierdaten aus dem Datenspeicher des Meßkopfes.

Betriebshinweise:

- ▶ Max. Eingangsleistung 100 mW
- ▶ Umgebungstemperatur 0 ... 50 °C
- ▶ HF-Anschluß nur von Hand und ohne Verkanten mit der Signalquelle verbinden
- ▶ Betauung vermeiden. Tritt trotzdem Betauung auf, so ist der Meßkopf vor dem Einschalten auszutrocknen
- ▶ Überlastungen bis 300 mW sind zulässig, die Leistung wird aber nicht mehr angezeigt.
- ▶ Beim Messen von Leistungen unter 300 μ W den Meßkopf einlaufen lassen (ca. 10 min), Erwärmung des Meßkopfes durch erwärmte HF-Anschlüsse der Signalquelle vermeiden.
- ▶ Die Kalibrierung gilt für Leistungen am HF-Stecker des Meßkopfes. Adapter zwischen Meßkopf und Signalquelle bewirken bei höheren Frequenzen zusätzliche Dämpfung und Meßfehler durch verschlechterte Anpassung.

3 Bedienung

3.1 Messen mit den Meßköpfen NRV-Z51, NRV-Z52 und NRV-Z55

3.1.1 Leistungs- und Spannungsmessung

Thermische Leistungsmesser messen den arithmetischen Mittelwert des Produktes der Momentanwerte von Spannung und Strom. Dies entspricht genau der Definition der elektrischen Wirkleistung.

$$P = \frac{1}{T} \int_0^T u \cdot i \cdot dt$$

Das bedeutet, daß im gesamten Aussteuerbereich unabhängig von der Kurvenform des Signals immer die tatsächliche Wirkleistung gemessen wird.

Wird am Grundgerät eine Spannungsanzeige gewählt, so wird die Spannung aus der gemessenen Leistung errechnet:

$$U = \sqrt{P \cdot Z_0} \quad (Z_0 = 50 \, \Omega \text{ für NRV-Z51/-Z52/-Z55})$$

U wird dabei als Effektivwert einer sinusförmigen Spannung berechnet, die am Wirkwiderstand Z_0 die Leistung P erzeugt.

3.1.2 Leistungsmeßbereiche

Der gesamte Meßbereich ist bei den Meßköpfen NRV-Z51/-Z52/-Z55 in fünf Teilbereiche unterteilt:

- 0 ... 10 μ W
- 10 ... 100 μ W
- 0,1 ... 1 mW
- 1 ... 10 mW
- 10 ... 100 mW

Die Grundgeräte NRVD und NRVS erlauben die Messung mit automatischer oder manueller Bereichswahl.

Mit automatischer Bereichswahl (AUTO RANGE) wird in Abhängigkeit vom Meßpegel der passende Meßbereich vom Gerät selbst eingestellt. Bei manueller Bereichswahl (FIX RANGE) kann vom Benutzer ein Meßbereich fest eingestellt werden. Damit läßt sich verhindern, daß jedesmal bei vorübergehender Wegnahme der Meßleistung automatisch wieder der empfindlichste Meßbereich eingestellt wird.

3.1.3 Meßgeschwindigkeit und Rauschen

Je kleiner das Meßsignal ist, um so stärker wirkt sich das unvermeidlich in elektronischen Schaltungen entstehende Rauschen aus. Es bewirkt Schwankungen des Anzeigewertes. Um hohe Meßgenauigkeit zu erreichen, ist eine Filterung des Meßsignals nötig. Je wirksamer diese Filterung sein muß, um so stärker verringert sich aber auch die Meßgeschwindigkeit.

Die Grundgeräte NRVD und NRVS bieten die Möglichkeit, mit automatischer oder manueller Filtereinstellung zu messen.

Bei der automatischen Filtereinstellung ist sichergestellt, daß in Abhängigkeit vom Meßbereich und der vom Benutzer gewählten Anzeigauflösung das optimale Filter eingestellt wird. Aus der Filtereinstellung ergibt sich die Meßgeschwindigkeit. Sehr kleine Meßsignale (also niedriger Meßbereich) und hohe Anzeigauflösung erfordern die wirksamste Filterung und ergeben damit die geringste Meßgeschwindigkeit.

Wenn die automatische Filterwahl einem speziellen Meßfall nicht optimal angepaßt erscheint, also beispielsweise eine größere Meßgeschwindigkeit (zu Lasten des Anzeigerausens) gefordert wird, kann manuell ein anderes Filter eingestellt werden.

Der Zusammenhang zwischen Filternummer, Meßzeit und Rauschen ist den Technischen Daten zu entnehmen.

3.1.4 Nullabgleich

Beim Messen kleiner Leistungen kann ein additiver Offset -positiver oder negativer Polarität-, wie er z.B. durch Thermospannungen am Meßkopf entsteht, das Meßergebnis verfälschen. Beim Nullabgleich wird der Offset gemessen, gespeichert und von den nachfolgenden Meßwerten subtrahiert.

Hinweis zum Nullabgleich

- ▶ Am Meßkopf darf keine Meßleistung anliegen.
- ▶ Nach dem Messen großer Leistungen mit dem Start des Nullabgleiches warten, bis der Anzeigewert stabil geworden ist.
- ▶ Während des Nullabgleiches das Meßkopfkabel nicht stark bewegen.
- ▶ Nullabgleich bei wechselnder Umgebungstemperatur oder noch nicht voll eingelaufenem Gerät von Zeit zu Zeit ohne anliegende Meßleistung kontrollieren und ggf. wiederholen.
- ▶ Durch Masseschleifen können externe Offsets entstehen. Wenn sich diese durch korrekte Erdung nicht ganz beseitigen lassen, bleibt der Meßkopf am Signalgenerator (bei abgeschalteter Meßleistung) auch während des Nullabgleiches angeschlossen. Dadurch wird auch der externe Offset erfaßt und bei der Berechnung des Anzeigewertes berücksichtigt.
- ▶ Die Nullpunktkorrektur wird nach dem Ausschalten des Gerätes nicht gespeichert. Sie sollte deswegen nach jedem Einschalten ausgeführt werden.

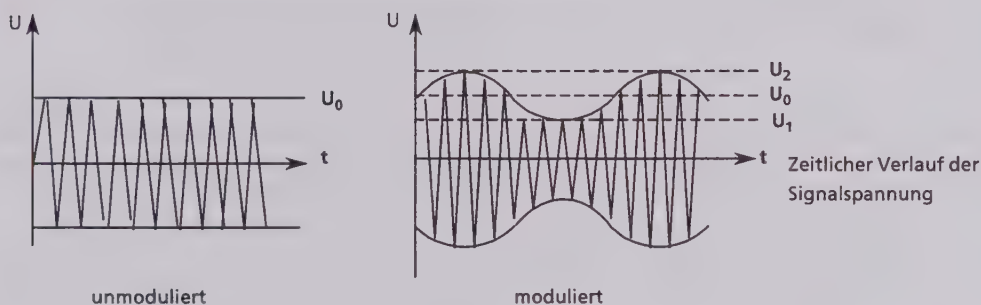
3.1.5 Frequenzgangkorrektur

Der Frequenzgang jedes Meßkopfes wird bei der Kalibrierung individuell gemessen und bei einer Vielzahl von Frequenzen als Kalibrierfaktor (Verhältnis von angezeigter zu zugeführter Leistung) im Datenspeicher des Meßkopfes gespeichert. Die Berücksichtigung der Frequenzgangkorrektur erfolgt durch Eingabe der Meßfrequenz in das Grundgerät. Liegt die eingegebene Frequenz zwischen zwei Kalibrierfrequenzen, so wird der zugehörige Kalibrierfaktor durch lineare Interpolation errechnet. Für die Meßköpfe NRV-Z51/-Z52/-Z55 sind die Kalibrierfaktoren auf die Meßkopfempfindlichkeit bei 50 MHz bezogen. Wird ohne Frequenzgangkorrektur gemessen, erfolgt die Anzeige des Meßergebnisses so, als würde bei 50 MHz gemessen.

3.1.6 Messen modulierter Signale

Die Fähigkeit thermischer Meßköpfe, auch bei beliebig modulierten Signalen die mittlere Leistung zu messen, ermöglicht die Bestimmung des Modulationsgrads bei amplitudenmodulierten Trägern (nur NRVD) und der Impulsleistung bei pulsmodulierter HF (NRVD, NRV5, URV55).

Bestimmung des Modulationsgrades:



Der Modulationsgrad wird errechnet aus:

$$m = \frac{(U_2 - U_1) / 2}{U_0}$$

Bei Amplitudenmodulation entstehen oberhalb und unterhalb der Trägerfrequenz zwei Seitenbandfrequenzen mit der Amplitude

$$U = \frac{m}{2} \cdot U_0$$

was einer Zunahme der Leistung entspricht.

Unmodulierte Leistung:

$$P_{unmod} = \frac{U_0^2}{Z_0}$$

Modulierte Leistung:

$$P_{mod} = \frac{U_0^2}{Z_0} + 2 \cdot \frac{(U_0 \cdot m/2)^2}{Z_0} = P_{unmod} \cdot \left(1 + \frac{m^2}{2}\right)$$

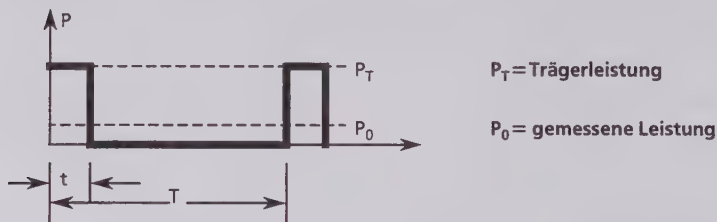
Aus den gemessenen Leistungen mit und ohne Modulation errechnet sich der Modulationsgrad:

$$m = \sqrt{2 \cdot (P_{mod} / P_{unmod} - 1)}$$

Für genaue Messungen des Modulationsgrades ist es erforderlich, daß der Trägermittelwert U_0 bei Modulation konstant bleibt und die Modulation exakt sinusförmig ist.

Messung pulsmodulierter Leistung:

Bei pulsmodulierten Signalen kann aus dem Tastverhältnis (Duty Cycle) die Trägerleistung errechnet werden. Zur Unterscheidung von der physikalisch meßbaren maximalen Hüllkurvenleistung (PEP) wird dieser Wert als Impulsleistung bezeichnet.



Zur Berechnung der Trägerleistung geht man davon aus, daß die Energie der mittleren, gemessenen Leistung P_0 während der Zeit T genau so groß ist wie die Energie der Trägerleistung P_T in der Zeit t :

$$P_0 \cdot T = P_T \cdot t$$

$$P_T = \frac{T}{t} \cdot P_0$$

Bei der Messung modulierter Signale ist zu beachten, daß die thermischen Meßköpfe einen Zerschaltungsverstärker enthalten, deren Hackfrequenz ca. 575 Hz beträgt. Modulation mit dieser Frequenz, dem halben, doppelten oder dreifachen Wert kann periodische Anzeigeschwankungen bewirken. In diesem Fall sollte die Modulationsfrequenz geringfügig verändert werden.

3.2 Meßgenauigkeit

Unvermeidlich ist jede Messung mit Meßfehlern unterschiedlicher Ursachen behaftet. Der tatsächlich bei einer beliebigen Messung entstehende Wert des Fehlers ist fast nie bekannt. Man kann nur Angaben machen über die möglichen Maximalwerte der Einzelfehler und daraus Grenzen errechnen, zwischen denen der Gesamtfehler liegen kann.

3.2.1 Fehlanpassung

Mit den thermischen Meßköpfen NRV-Z51/-Z52/-Z55 soll die Leistung gemessen werden, die eine Quelle an einen Verbraucher mit dem reellen Widerstand Z_0 liefern kann. Im allgemeinen weichen aber sowohl die Impedanz der Quelle wie auch die Impedanz des als Verbraucher wirkenden Leistungsmeßkopfes vom Wert Z_0 ab. Der durch diese gegenseitige Fehlanpassung entstehende Leistungsfehler errechnet sich aus:

$$E_p = \frac{1 - |\Gamma_l|^2}{|1 - \Gamma_g \cdot \Gamma_l|^2} - 1$$

Γ_g : komplexer Reflexionsfaktor der Quelle

Γ_l : komplexer Reflexionsfaktor des Verbrauchers

Der Zähler $1 - |\Gamma_l|^2$ in obiger Gleichung ergibt einen Fehleranteil, der nur vom Verbraucher verursacht wird. Er wird bei den Leistungsmeßköpfen durch Messung bei der Kalibrierung bestimmt und ist im Kalibrierfaktor (siehe Abschn. 3.2.2) enthalten.

Ein zweiter Fehleranteil entsteht durch den Nenner $|1 - \Gamma_g \cdot \Gamma_l|^2$. Da Γ_l und Γ_g komplexe Wechselstromgrößen sind, kann je nach ihrer Phasenlage der Fehler positiv oder negativ werden. Im allgemeinen ist der Reflexionsfaktor Γ_g der Quelle nach Betrag und Phase nicht bekannt, deswegen kann die Größe dieses Fehlers im Datenblatt nicht angegeben werden und in der Praxis auch nicht berechnet werden.

Wohl aber lassen sich die Fehlergrenzen aus den Maximalwerten der Beträge der Reflexionsfaktoren bestimmen. Die durch Fehlanpassung zwischen Quelle und Verbraucher entstehende Meßunsicherheit (engl.: mismatch uncertainty M_u) errechnet sich in Prozent der Leistung:

$$M_u [\%] = 100 \cdot [(1 \pm r_g \cdot r_l)^2 - 1]$$

Näherungsweise gilt:

$$M_u [\%] \approx \pm 200 \cdot r_g \cdot r_l$$

r_g : Betrag Reflexionsfaktor der Quelle

r_l : Betrag Reflexionsfaktor des Verbrauchers

3.2.2 Kalibrierunsicherheit

Weil der Reflexionsfaktor eines Leistungsmeßkopfes unvermeidlich größer als Null (bzw. sein SWR > 1) ist, wird ein Teil der dem Meßkopf angebotenen Leistung reflektiert. Daher werden alle Leistungsmeßköpfe während der Fertigung bei einer Vielzahl von Kalibrierfrequenzen individuell vermessen. Die gemessene Leistung wird dabei mit der vom Kalibriersystem gelieferten verglichen und das Verhältnis beider Werte als Kalibrierfaktor gespeichert.

Bei eingeschalteter Frequenzgangkorrektur wird das Meßergebnis mit dem zur eingegebenen Meßfrequenz gehörigen Kalibrierfaktor verrechnet.

Alle von R&S verwendeten Meßsysteme zur Kalibrierung von Leistungsmeßköpfen sind rückführbar auf die entsprechenden Primärnormale der Physikalisch-Technischen Bundesanstalt PTB.

Dessen ungeachtet ist auch die Bestimmung des Kalibrierfaktors mit Meßunsicherheiten behaftet, die sich aus Anpassungsfehlern, Leistungs-Übertragungsfehlern und der Meßunsicherheit der PTB-Primärnormale ergeben. Die Fehlergrenzen des Kalibrierfaktors sind abhängig von der Frequenz und dem jeweiligen Meßkopf im Datenblatt als RSS-Fehler (siehe Abschn. 3.2.7) angegeben.

3.2.3 Linearitätsfehler

Von einem idealen Leistungsmesser erwartet man einen streng proportionalen Zusammenhang zwischen der anliegenden Meßleistung und der angezeigten Meßleistung über den gesamten Meßbereich. Von diesem idealen Verhalten weichen reale Leistungsmesser mehr oder weniger ab, es entsteht ein Linearitätsfehler, der von der Aussteuerung abhängig ist.

Bei den thermischen Leistungsmeßköpfen ist der Linearitätsfehler sehr klein, weil die Aussteuerkennlinie von jedem Meßkopf in der Fertigung individuell gemessen und im Meßkopf-Datenspeicher nichtflüchtig gespeichert wird. Mit diesen Daten wird die vom Grundgerät angezeigte Leistung rechnerisch korrigiert, so daß eine fast perfekte Linearisierung entsteht. Der verbleibende Restfehler ist in den Technischen Daten der Meßköpfe spezifiziert.

3.2.4 Anzeigerauschen

Das dem vom Meßkopf erzeugten Ausgangssignal überlagerte Rauschen bewirkt geringe Schwankungen des Anzeigewertes, die einen Meßfehler ergeben. Da die Entstehung des Rauschens ein statistischer Prozeß ist, ist es zweckmäßig, die Größe des Rauschens mit den Methoden der Wahrscheinlichkeitsrechnung zu beschreiben.

R&S gibt für die Rauschleistung den zweifachen Wert der Standardabweichung an. Das bedeutet, daß bei 95% einer statistisch hinreichend großen Anzahl von Messungen dieser Wert der Rauschleistung nicht überschritten wird.

Das Anzeigerauschen ist eine additive Größe, d.h. der vom Rauschen verursachte Fehler wird um so kleiner, je größer die Meßleistung ist.

Der Wert des Anzeigerausches kann durch die Filtereinstellung (siehe Abschn. 3.1.3) beeinflusst werden: Jede zusätzliche Verdopplung bei der Mittelwertbildung verringert die Anzeigerauscheinleistung um ca. 30%.

3.2.5 Nullpunktfehler

Ein Nullpunktfehler entsteht, wenn ohne Meßleistung eine von Null verschiedene Leistung angezeigt wird. Ursache für diesen Offset sind zumeist Temperaturänderungen, denen der Meßkopf ausgesetzt ist. Beim Nullabgleich (siehe Abschn. 3.1.4) wird der Offset gemessen und bei der nachfolgenden Messung vom Meßwert subtrahiert.

Auch der Nullpunktfehler ist eine additive Größe, deren Fehlereinfluß um so geringer wird, je größer die Meßleistung ist. Beim Messen kleiner Leistungen empfiehlt es sich daher, Temperaturänderungen, wie sie durch auf den Meßkopf übertragene Handwärme oder erwärmte HF-Anschlüsse von Meßsendern entstehen können, gering zu halten und den Nullabgleich von Zeit zu Zeit zu wiederholen.

3.2.6 Temperatureinfluß

Beim Temperatureinfluß handelt es sich um einen Zusatzfehler, der bei konstanter, aber von 23 °C abweichender Temperatur entsteht.

Durch die zyklische Temperaturmessung kann mit Hilfe des gespeicherten Temperaturverhaltens der Einfluß wechselnder Umgebungstemperaturen bis auf einen sehr kleinen Restfehler rechnerisch korrigiert werden. Er beträgt etwa 0,1 %/grd, bezogen auf die Kalibriertemperatur von 23 °C.

3.2.7 Fehler des Grundgerätes

Das Analogteil der Grundgeräte besteht im Prinzip aus einem präzisen Gleichspannungsverstärker und einem hochauflösenden A/D-Wandler. Der angegebene Fehler entsteht lediglich durch Drift von Verstärkungsfaktoren (Zeit, Temperatur) und bezieht sich - wie alle anderen Fehler - auf den Meßwert. Da der typische Fehler i.a. noch wesentlich kleiner ist, kann der Grundgerätefehler gegenüber den anderen Meßunsicherheiten vernachlässigt werden.

3.2.8 Maximal- und RSS-Fehler

Eine korrekte Fehlerangabe muß zwei Aussagen enthalten:

- wie groß sind die Fehlergrenzen und
- wie groß ist das Vertrauensniveau, d.h. wieviele Meßergebnisse aus einer großen Anzahl von Messungen überschreiten die Fehlergrenzen nicht.

Beim Maximalfehler ist das Vertrauensniveau 100 %: Bei keiner Messung werden die Fehlergrenzen überschritten. Der Maximalfehler $E_{\max}$ ist die Summe aller einzelnen Maximalfehler $(E_{\max})_i$:

$$E_{\max} = \sum_{i=1}^N (E_{\max})_i$$

In der Praxis stellt man fest, daß der Maximalfehler nur selten erreicht wird. Wenn sich der Gesamtfehler aus vielen Einzelfehlern zusammensetzt, die voneinander unabhängige Ursachen haben (und das ist bei den bisher beschriebenen Einzelfehlern der Fall), so ist es statistisch ein sehr seltenes Ereignis, daß bei einer Messung sämtliche Einzelfehler gleichzeitig mit ihrem maximalen Wert und gleichem Vorzeichen auftreten.

In der Leistungsmeßtechnik hat es sich daher eingebürgert, den praxisnäheren RSS-Fehler (RSS: Root Sum of the Squares) anzugeben.

Er ist die Quadratwurzel aus der Summe der Quadrate der einzelnen RSS-Fehler $(E_{RSS})_i$:

$$E_{RSS} = \sqrt{\sum_{i=1}^N (E_{RSS})_i^2}$$

Der RSS-Fehler einer Summe von Einzelfehlern ist der Fehler, der i.a. bei 95 % aller Meßergebnisse nicht überschritten wird.

3.2.9 Gesamt-Meßunsicherheit

An einem Beispiel wird die Gesamt-Meßunsicherheit (als RSS-Wert) berechnet unter folgenden Meßbedingungen:

- Meßkopf NRV-Z51
- Meßleistung 5 mW
- Frequenz 6,5 GHz
- Umgebungstemperatur 24 °C
- SWR der Quelle 1,35 ($r=0,15$)
- Filter NRVD 4

Das folgende Beispiel zeigt, daß der größte Einzelfehler durch Fehlanpassung zwischen Quelle und Meßkopf entsteht. Durch bessere SWR-Werte der Quelle kann man demzufolge die Meßgenauigkeit am nachhaltigsten steigern.

Fehlerursache	Beschreibung in Abschnitt	Einzelfehler (RSS) in %
Fehlanpassung $r_g = 0,15$ $r_l = 0,07$	3.2.1	2,1
Kalibrierunsicherheit	3.2.2	1,3
Linearität	3.2.3	0,3
Nullpunkt ± 60 nW	3.2.5	≈ 0
Rauschen ± 240 nW	3.2.4	≈ 0
Grundgerät NRVD	3.2.7	0,3
Temperatur	3.2.6	0,1
RSS Gesamt-Meßunsicherheit		$\pm 2,51\%$

4 Wartung und Fehlersuche

4.1 Wartung

Die Meßköpfe NRV-Z51/-Z52/-Z55 sind wartungsfrei. Der HF-Stecker sollte von Zeit zu Zeit gereinigt werden. Festsitzende Verunreinigungen können mit einem Pinsel und Alkohol entfernt werden.

4.2 Fehlersuche

Die Fehlersuche kann sich nur auf die Klärung beschränken, ob ein Meßkopf defekt ist. Reparaturen erfordern fast immer eine neue Kalibrierung, die vom Hersteller durchgeführt werden muß.

Wenn die Sollwerte der folgenden Prüfungen nicht eingehalten werden, ist der Meßkopf fehlerhaft und sollte zur Reparatur gegeben werden.

4.2.1 Prüfung der Meßkopfempfindlichkeit

Prüfaufbau:

- ▶ Meßkopf direkt (ohne HF-Kabel) an den Testgenerator des NRVD anschließen. Am NRVD Korrekturfrequenz 50 MHz eingeben, Nullabgleich durchführen, Testgenerator einschalten.

Sollwert der Leistungsanzeige:

- ▶ 0,98 ... 1,02 mW (18 ... 23 °C)

4.2.2 Prüfung SWR

Prüfaufbau:

- ▶ Meßkopf direkt (ohne HF-Kabel) an einen SWR-Netzwerkanalysator anschließen.
Bei der Prüfung ist die Meßunsicherheit des verwendeten Netzwerkanalysators zu berücksichtigen.

Sollwerte SWR:

Frequenz	Maximum SWR (r)
DC...2 GHz	1,1 (0,048)
2...12,4 GHz	1,15 (0,07)
12,4...18 GHz	1,2 (0,09)
18...26,5 GHz (NRV-Z52, NRV-Z55)	1,25 (0,11)
26,5...40 GHz (nur NRV-Z55)	1,30 (0,13)

5 Prüfen der Solleigenschaften

Leistungs- und Reflexionsmessungen im Frequenzbereich bis 40 GHz erfordern wegen der vielfältigen Fehlerquellen großen apparativen Aufwand, Erfahrung und besondere Sorgfalt.

Eine Nachmessung der in den Technischen Daten garantierten Eigenschaften sollte daher nur bei entsprechenden Kalibrierstellen oder in den Service-Einrichtungen von R&S durchgeführt werden.

Für die Meßköpfe NRV-Z51, NRV-Z52 und NRV-Z55 wird eine jährliche Überprüfung, ggf. mit Kalibrierung beim Hersteller empfohlen.



ROHDE & SCHWARZ

Test and Measurement
Division

Manual

Thermal Power Sensor

NRV-Z51 (0 ... 18 GHz)

857.9004.02

NRV-Z52 (0 ... 26.5 GHz)

857.9204.02

NRV-Z55 (0 ... 40 GHz)

1081.2005.02





ROHDE & SCHWARZ
EC Certificate of Conformity



Certificate No.: 9502231

This is to certify that:

Equipment type	Order No.	Designation
NRV-Z1	0828.3018.02/.03	Power Sensor
NRV-Z2	0828.3218.02/.03	"
NRV-Z3	0828.3418.02/.03	"
NRV-Z4	0828.3618.02/.03	"
NRV-Z5	0828.3818.02/.03	"
NRV-Z6	0828.5010.02	"
NRV-Z15	1081.2305.02	"
NRV-Z31	0857.9604.02/.03/.04	Peak Power Sensor
NRV-Z32	1031.6807.04/.05	"
NRV-Z33	1031.6507.03/.04	"
NRV-Z51	0857.9004.02	Thermal Power Sensor
NRV-Z52	0857.9204.02	"
NRV-Z53	0858.0500.02	"
NRV-Z54	0858.0800.02	"
NRV-Z55	1081.2005.02	"

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electromagnetic compatibility
(89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1995

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 26.11.96

Central Quality Management FS-QZ / Becker



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ROHDE & SCHWARZ

Power Sensors **NRV-Z**

for RF and microwave power measurements



The right sensor for every application

Power Sensors NRV-Z

for RF and microwave power measurements



With its large variety of power sensors Rohde & Schwarz is able to provide the right tools for all power measurements using a power meter from the NRV family.

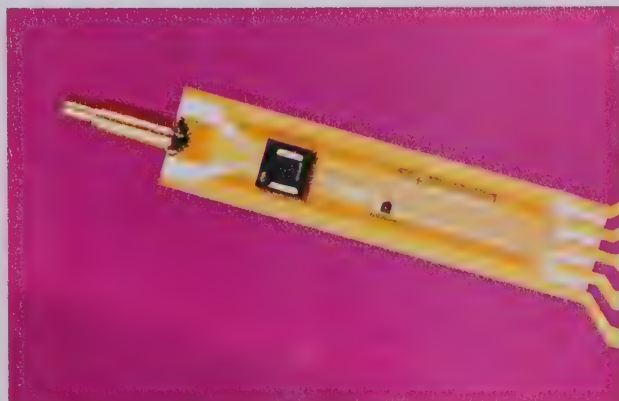
Ten power sensors in all cover the frequency range from DC to 26.5 GHz. Three classes of sensitivity enable direct measurement of any level between 400 pW and 500 mW. Higher powers up into the kW range can be measured when connecting directional couplers or power attenuators to the input of the sensor. A 75- Ω sensor is available for TV and video applications.

Plug-in and go

Using the calibrated power sensors of the NRV family for high-precision measurements has the great advantage that no time is wasted for calibration. The built-in calibration data memory contains all the relevant information and relieves the user from error-prone and time-consuming work. There is no need for regular recalibration of the power meter following a temperature change or change of the power sensor nor is it necessary to read

and enter correction factors. With a power sensor plugged in, a fully calibrated power meter is immediately ready for measurements. In addition to the data required for measurements, the calibration data memory also contains information simplifying the operation: instead of having to deal with code numbers which may mean 100 nW in one case and 1 mW in the other, the users of NRVD and NRVS can select all measurement ranges in plain text.

Interior view of Thermocouple Power Sensor NRV-Z51: precision in semiconductor and thin-film technology



DC to 26.5 GHz
400 pW to 0.5 W

The right sensor for every application

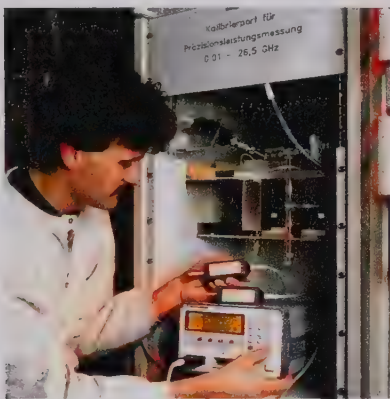
Power sensors absorb the RF power applied and provide at their output an equivalent DC voltage. To cover the complete power range from less than 1 nW to more than 100 mW, two different types of power sensors are required: thermocouple sensors based on the Seebeck effect and semiconductor detectors using zero-bias Schottky diodes of ultramodern technology. Both types of transducers are available for the entire frequency spectrum.

Thermocouple sensors like the NRV-Z51 cover the power range from 1 μ W to 100 mW. Irrespective of the waveform, they always indicate the RMS power. Being individually calibrated, the Rohde & Schwarz thermocouple power sensors feature an unrivalled linearity over the entire dynamic range.

High-sensitivity sensors based on diode detectors like the NRV-Z4 are indispensable

0.4 nW to 10 μ W. These sensors also measure the true RMS power in the specified range and can be easily used for signals with harmonic contents, noisy or modulated signals.

Medium-sensitivity sensors based on diode detectors with 20-dB input attenuators like the NRV-Z5 close the gap between the high-sensitivity and the thermocouple sensors. Due to their excellent matching and short measurement times they are ideal sensors for true RMS power measurements in the range from 1 μ W to 1 mW.



Calibration of NRV power sensors is directly traceable to the Federal German Bureau of Standards

With signals of relatively high spectral purity, the diode power sensors can be used far beyond the RMS range: the high-sensitivity sensors up to about 20 mW and the medium-sensitivity sensors up to 0.5 W. The extremely large dynamic range makes these sensors highly suitable for reflection and attenuation measurements. The fast measurement rate at higher power ratings is an advantage in system applications.

Precision calibration

Each NRV power sensor has all the measurement-relevant information in its built-in data memory. The correlation between the measu-

red power and the sensor output signal is established via frequency-dependent calibration factors. These calibration factors can only be precisely determined with the aid of special measuring instruments. To enhance the measurement accuracy, the standards used are directly linked to the primary standards of the Federal German Bureau of Standards.

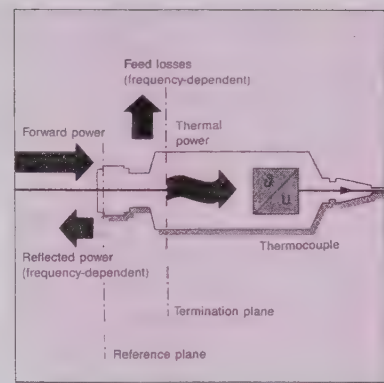
However, measurement errors do arise in the determination of the calibration factors. The individual error components are summed statistically and specified in the technical data as RSS calibration uncertainty with a confidence level of about 95%.

The calibration factors are defined so that all power sensors provide reading of the forward power, i.e. the power applied to the sensor. They take into account power losses caused by reflections as well as the loss of RF power between the connector and the sensor (see diagram).

After the test frequency has been entered, all power meters of the NRV family automatically scan the data memory for the relevant calibration factor to correct the indicated power.

Excellent matching

The NRV-Z power sensors feature excellent matching. Low SWR throughout the frequency range makes for relatively small matching errors. Mismatch, however, still is the main uncertainty factor in power measurements.

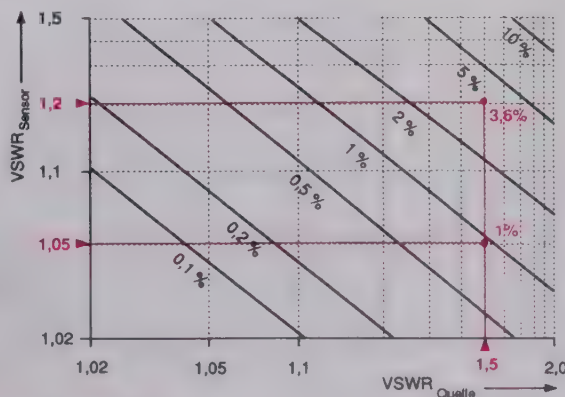


Power meters are calibrated to forward power reading; diagram showing power flow of thermocouple power sensor

Sources with poor matching, in particular, do not supply the rated power to the sensor, but significantly higher or lower values, depending on the reflected power. The more the sensor is matched, the less is the effect of reflections. The measurement error limits are shown in the diagram below.

Example: power measurement on a source with a SWR of 1.5. A well-matched sensor with a SWR of 1.05 causes a mismatch uncertainty of as little as 1% while a badly matched sensor (SWR = 1.2) will produce an uncertainty of 3.6% (red curve).

Measurement uncertainty (in percent of power) caused by mismatch of source and sensor (red: example described in text)



Power meters

Six power meters are available for power measurements using the NRV sensors.

NRVD Modern dual-channel power meter with menu operation and high-speed IEC/IEEE-bus connector (SCPI). Ideal for relative measurements in two test channels (attenuation, reflection). Large variety of measurement functions, result display in all standard units. Many extras like 1-mW test generator, indication of measurement uncertainty, etc. All power sensors suitable.

NRVS Attractively priced, single-channel power meter, same operation as NRVD. Many measurement functions, result display in all standard units, analog output fitted as standard. IEC/IEEE-bus connector, syntax-compatible with NRV/URV 5. All power sensors suitable.

NRV Well-proven dual-channel power meter for use in labs and systems. Many measurement functions, result display in all standard units, IEC/IEEE-bus connector. All power sensors, except for NRV-Z51/Z52, suitable.

URV 35 Compact voltmeter and power meter for use in service, testshops and labs. Unique combination of analog and digital display in form of moving-coil meter plus LCD. Many measurement functions, display in all standard units, choice of battery or AC supply operation, RS-232 interface. All power sensors suitable.

URV 55 Attractively priced, single-channel voltmeter, similar to NRVS. All power sensors suitable.

URV 5 Dual-channel voltmeter, similar to NRV. All power sensors, except for NRV-Z51/Z52, suitable.

Measuring heads for voltage and level measurement

Probes and insertion units (data sheet PD 756.9816) further enhance the application range of the NRV power meter family.

RF Probe URV 5-Z7

For virtually no-load measurements in RF circuits up to 400 MHz. Comprehensive accessories, including adapters for 50- Ω and 75- Ω connectors.

DC Probe URV 5-Z1

For low-load DC measurements in RF circuits from 1 mV to 400 V.

Insertion Units URV 5-Z2/Z4

For level measurement between source and load in coaxial 50- Ω and 75- Ω systems. With an optimally matched load, power measurements from -60 to +53 dBm are even possible without directional coupler. Frequency range 9 kHz to 2 GHz.

Dual Directional Coupler URV 5-Z9

For directional power and reflection measurements in conjunction with two RF Probes URV 5-Z7. Frequency range 100 kHz to 80 MHz, power measurement range 10 μ W to 2 kW.

NRVD



URV 35



NRVS



URV 55



NRV



URV 5



Specifications

High-sensitivity sensors

RMS weighting up to 10 μ W

Model	Frequency range	Power range Max. power	SWR (reflection coefficient)	Zero error ($\pm$) ¹⁾	Meter noise 2 σ ²⁾	Linearity error ($\pm$) ³⁾	Connector
NRV-Z4	100 kHz to 6 GHz	500 pW to 20 mW 100 mW (avg) 100 mW (pk)	0.1 to 100 MHz: 1.05 (0.024) 0.1 to 2 GHz: 1.1 (0.048) 2 to 4 GHz: 1.2 (0.09) 4 to 6 GHz: 1.35 (0.15)	50 pW	20 pW	0.4 %	N
NRV-Z7	10 MHz to 13 GHz	1 nW to 20 mW 100 mW (avg) 100 mW (pk)	0.01 to 1 GHz: 1.06 (0.03) 1 to 2 GHz: 1.13 (0.06) 2 to 4 GHz: 1.27 (0.12) 4 to 13 GHz: 1.41 (0.17)	100 pW	40 pW	0.4 %	N
NRV-Z1	10 MHz to 18 GHz	1 nW to 20 mW 100 mW (avg) 100 mW (pk)	0.01 to 1 GHz: 1.06 (0.03) 1 to 2 GHz: 1.13 (0.06) 2 to 4 GHz: 1.27 (0.12) 4 to 18 GHz: 1.41 (0.17)	100 pW	40 pW	0.4 %	N
NRV-Z6	50 MHz to 26.5 GHz	1 nW to 20 mW 100 mW (avg) 100 mW (pk)	0.05 to 0.1 GHz: 1.3 (0.13) 0.1 to 18 GHz: 1.2 (0.09) 18 to 26.5 GHz: 1.4 (0.165)	200 pW	80 pW	0.5 %	PC 3.5
NRV-Z3 75 Ω	1 MHz to 2.5 GHz	400 pW to 13 mW 70 mW (avg) 70 mW (pk)	0.001 to 1 GHz: 1.11 (0.05) 1 to 2.5 GHz: 1.2 (0.09)	40 pW	16 pW	0.4 %	N

Medium-sensitivity sensors

RMS weighting up to 1 mW

Model	Frequency range	Power range Max. power	SWR (reflection coefficient)	Zero error ($\pm$) ¹⁾	Meter noise 2 σ ²⁾	Linearity error ($\pm$) ³⁾	Connector
NRV-Z5	100 kHz to 6 GHz	50 nW to 500 mW 2 W (avg) 10 W (pk)	100 kHz to 4 GHz: 1.05 (0.024) 4 to 6 GHz: 1.1 (0.048)	5 nW	2 nW	0.3 %	N
NRV-Z8	10 MHz to 13 GHz	100 nW to 500 mW 2 W (avg) 10 W (pk)	0.01 to 4 GHz: 1.05 (0.024) 4 to 8 GHz: 1.1 (0.048) 8 to 13 GHz: 1.15 (0.07)	10 nW	4 nW	0.3 %	N
NRV-Z2	10 MHz to 18 GHz	100 nW to 500 mW 2 W (avg) 10 W (pk)	0.01 to 4 GHz: 1.05 (0.024) 4 to 8 GHz: 1.1 (0.048) 8 to 12.4 GHz: 1.15 (0.07) 12.4 to 18 GHz: 1.2 (0.09)	10 nW	4 nW	0.3 %	N

Thermocouple sensors

RMS weighting in complete measurement range

Model	Frequency range	Power range Max. power	SWR (reflection coefficient)	Zero error ($\pm$) ¹⁾	Meter noise 2 σ ²⁾	Linearity error ($\pm$) ³⁾	Connector
NRV-Z51	DC to 18 GHz	1 μ W to 100 mW 300 mW (avg) 10 W (pk, 1 μ s)	DC to 2 GHz: 1.1 (0.048) 2 to 12.4 GHz: 1.15 (0.07) 12.4 to 18 GHz: 1.2 (0.09)	60 nW	22 nW	0.6 %	N
NRV-Z52	DC to 26.5 GHz	1 μ W to 100 mW 300 mW (avg) 10 W (pk, 1 μ s)	DC to 2 GHz: 1.1 (0.048) 2 to 12.4 GHz: 1.15 (0.07) 12.4 to 18 GHz: 1.2 (0.09) 18 to 26.5 GHz: 1.25 (0.11)	60 nW	22 nW	0.6 %	PC 3.5

Calibration uncertainties

RSS in %, referred to indicated power

Frequency (MHz)	NRV-Z3	NRV-Z4	NRV-Z5	Frequency (GHz)	NRV-Z1/Z7 ⁴⁾	NRV-Z2/Z8 ⁴⁾	NRV-Z51	NRV-Z6	NRV-Z52
0.1	-	0.8	0.8	0.01	1.6	0.8	0.6	-	0.7
0.15	-	0.8	0.8	0.05	1.6	0.8	0.6	1.3	0.7
0.2	-	0.8	0.8	0.1	1.6	0.8	0.6	1.3	0.7
0.455	-	0.8	0.8	0.5	2.1	1.5	0.8	1.3	1.0
1	1.1	0.8	0.8	1	2.1	1.5	0.8	1.3	1.0
1.25	1.1	-	-	1.5	2.1	1.5	-	-	-
3	1.1	-	-	2	2.1	1.5	0.8	1.3	1.0
10	1.1	0.8	0.8	2.5	2.6	1.8	-	-	-
30	1.1	-	-	3	2.6	1.8	1.3	1.8	1.6
50	1.1	0.8	0.8	3.5	2.6	1.8	-	-	-
100	1.1	0.8	0.8	4	2.6	1.8	1.3	1.8	1.6
500	1.6	1.5	1.4	4.4	3.8	2.0	-	-	-
1000	1.6	1.5	1.4	5	3.8	2.0	1.3	1.8	1.6
1200	2.0	-	-	5.4	3.8	2.0	-	-	-
1400	2.0	-	-	6	3.8	2.0	1.3	1.8	1.6
1500	-	1.5	1.4	6.4	3.8	2.0	-	-	-
1600	2.0	-	-	7	3.8	2.0	1.3	1.8	1.6
1800	2.0	-	-	7.4	3.8	2.0	-	-	-
2000	2.0	1.5	1.4	8	3.8	2.0	1.3	1.8	1.6
2200	2.0	-	-	8.4	4.0	2.8	-	-	-
2300	2.0	-	-	9	4.0	2.8	1.9	2.9	2.5
2400	2.0	-	-	9.4	4.0	2.8	-	-	-
2500	2.0	-	-	10	4.0	2.8	1.9	2.9	2.5
3000	-	1.8	1.7	10.4	4.0	2.8	-	-	-
3200	-	1.8	1.7	11	4.0	2.8	1.9	2.9	2.5
3400	-	1.8	1.7	11.4	4.0	2.8	-	-	-
3600	-	1.8	1.7	12	4.0	2.8	1.9	2.9	2.5
3800	-	1.8	1.7	12.4	4.0	2.8	1.9	2.9	2.5
4000	-	1.8	1.7	13	4.0	2.8	2.5	3.2	3.1
4200	-	2.2	1.9	13.5	5.6	3.3	-	-	-
4400	-	2.2	1.9	14	5.6	3.3	2.5	3.2	3.1
4600	-	2.2	1.9	14.5	5.6	3.3	-	-	-
4800	-	2.2	1.9	15	5.6	3.3	2.5	3.2	3.1
5000	-	2.2	1.9	15.5	5.6	3.3	-	-	-
5200	-	2.2	1.9	16	5.6	3.3	2.5	3.2	3.1
5400	-	2.2	1.9	16.5	5.6	3.3	-	-	-
5600	-	2.2	1.9	17	5.6	3.3	2.5	3.2	3.1
5800	-	2.2	1.9	17.5	5.6	3.3	-	-	-
6000	-	2.2	1.9	18	5.6	3.3	2.5	3.2	3.1
				19	-	-	-	2.8	2.5
				20	-	-	-	2.8	2.5
				21	-	-	-	2.8	2.5
				22	-	-	-	2.8	2.5
				23	-	-	-	2.8	2.5
				24	-	-	-	2.8	2.5
				25	-	-	-	2.8	2.5
				26	-	-	-	2.8	2.5
				26.5	-	-	-	2.8	2.5

Temperature effect

In %, referred to indicated power (typical values in parenthesis)

	22 to 24 °C	18 to 28 °C	10 to 40 °C	0 to 50 °C
NRV-Z1 to Z8	0 ⁵⁾	1.0 (0.3)	3.0 (1)	7.0 (2)
NRV-Z51/Z52	0 ⁵⁾	0.4 (0.1)	1.3 (0.4)	2.0 (0.5)

Total uncertainty

To calculate the total uncertainty of the source power available at Z₀, the following components have to be taken into account:

Mismatch uncertainty (see diagram)

Calibration uncertainty

Linearity error at 23 °C

Additional linearity error³⁾ (diode power sensors only, other than RMS range)

Meter noise, zero error, temperature effect

Error of power meter (see NRVs, NRVD, NRV specifications)

Additional linearity error³⁾ (diode power sensors only, other than RMS range)

General data

Operating temperature range	0 to +50 °C, class 1 to IEC 359 (without condensation)
Storage temperature range	-40 to +70 °C
Dimensions, weight	120 mm x 37 mm x 31 mm, 0.35 kg
Length of connecting cable	approx. 1.3 m; other lengths on request

Order designations

Power Sensor 20 mW, 50 Ω, 18 GHz	NRV-Z1	828.3018.02
Power Sensor 500 mW, 50 Ω, 18 GHz	NRV-Z2	828.3218.02
Power Sensor 13 mW, 75 Ω, 2.5 GHz	NRV-Z3	828.3418.02
Power Sensor 20 mW, 50 Ω, 6 GHz	NRV-Z4	828.3618.02
Power Sensor 500 mW, 50 Ω, 6 GHz	NRV-Z5	828.3818.02
Power Sensor 20 mW, 50 Ω, 26.5 GHz	NRV-Z6	828.5010.02
Power Sensor 20 mW, 50 Ω, 13 GHz	NRV-Z7	828.5210.02
Power Sensor 500 mW, 50 Ω, 13 GHz	NRV-Z8	828.5410.02
Power Sensor 100 mW, 50 Ω, 18 GHz	NRV-Z51	857.9004.02
Power Sensor 100 mW, 50 Ω, 26.5 GHz	NRV-Z52	857.9204.02



1) Within 1 h after zero adjustment, permissible temperature variation 1 °C, after 2 h warmup of power meter

2) Noise specifications (2 standard deviations) referred to filter 11, temperature 18 to 28 °C. With the most sensitive measurement range selected on NRVS and NRVD, filter 11 is automatically set (autofilter mode, resolution HIGH). The noise values for other filter settings are obtained by multiplication with the factors given in the table below.

Filter No.	NRVS/NRVD	0	1	2	3	4	5	6	7	8	9	10	11	12
	URV5/NRV	F5			F4		F3		F2		F1		F0	
Noise multiplier		51	32	23	16	11.3	8	5.6	4	2.8	2	1.4	1.0	0.7
Measurement	NRV-Z1 to Z8	0.045	0.05	0.06	0.08	0.15	0.27	0.49	0.95	1.85	3.6	7.2	14.5	28.5
time/s	NRV-Z51/Z52	0.115	0.12	0.13	0.15	0.21	0.32	0.52	0.92	1.75	3.4	6.6	13	26

The above measurement times are approximate values for remote-controlled operation. For accurate values please refer to NRVS, NRVD and NRV specifications.

3) Linearity referred to calibration power of 10 µW for high-sensitivity sensors, 1 mW for medium-sensitivity sensors and 1.6 mW for thermocouple sensors. All diode power sensors can be used for sinusoidal unmodulated signals far beyond the RMS range. Larger linearity errors can arise:

a) out of the temperature range 23 ± 2 °C (only relevant to relative measurements; irrelevant to calculation of total uncertainty, since already considered in temperature effect)

b) in the frequency and power ranges specified below (additional linearity error). The values specified must be taken into account in calculating the total uncertainty and in relative measurements.

NRV-Z4	1.5 to 3 GHz: +2 % (0.02 to 2 mW), +4 % (2 to 20 mW) 3 to 6 GHz: +6 % (0.02 to 2 mW), +10 % (2 to 20 mW)	NRV-Z5	1.5 to 3 GHz: +2 % (2 to 200 mW), +3.5 % (0.2 to 0.5 W) 3 to 6 GHz: +6 % (2 to 200 mW), +8 % (0.2 to 0.5 W)
NRV-Z1/Z7	4 to 8 GHz: +2 % (0.02 to 2 mW), +4 % (2 to 20 mW) 8 to 13 GHz: +5 % (0.02 to 2 mW), +10 % (2 to 20 mW) 13 to 18 GHz: +6 % (0.02 to 2 mW), +12 % (2 to 20 mW)	NRV-Z2/Z8	4 to 8 GHz: +2 % (2 to 200 mW), +3.5 % (0.2 to 0.5 W) 8 to 13 GHz: +5 % (2 to 200 mW), +8 % (0.2 to 0.5 W) 13 to 18 GHz: +6 % (2 to 200 mW), +10 % (0.2 to 0.5 W)
NRV-Z6	0.05 to 0.2 GHz: -2.5/+0.5 % (0.02 to 2 mW), -4.5/+1.5 % (2 to 20 mW) 0.2 to 14 GHz: ±0.5 % (0.02 to 2 mW), ±1.5 % (2 to 20 mW) 14 to 26.5 GHz: -0.5/+1.5 % (0.02 to 2 mW), -0.5/+4.5 % (2 to 20 mW)		

NRV-Z3 without additional error

4) Power Sensors NRV-Z7/Z8 calibrated up to 13 GHz only.

5) Included in calibration uncertainty



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40-GHz Power Sensors

NRV-Z55

NRV-Z15

Technical Information

Subject to change 4/97-1GP3-Rei

40-GHz Power Sensors NRV-Z55, NRV-Z15

Technical Information

R&S 40-GHz Power Sensors

Rohde & Schwarz is continuously expanding its line of precision power sensors for the NRVS, NRVD, URV35 and URV55 power and level meters. The new Thermal Power Sensor NRV-Z55 offers all the benefits of the thermoelectric principle (1 μ W to 100 mW) together with an outstanding SWR and an ultrawide frequency range from DC to 40 GHz. The new Diode Power Sensor NRV-Z15 from 50 MHz to 40 GHz expands the power measurement range down to 1 nW, with true-rms response up to 10 μ W. Between 10 μ W and 20 mW it should be used for CW signals and all applications where speed counts. Since both sensors come fully calibrated, there is no need for manual calibration upon plugging onto the basic unit or due to temperature changes. It is this feature that makes them the right choice for universal use. Together with the battery-operated URV35 they ensure rapid and precise on-site

measurements. They are suitable for use on NRVS and NRVD in the laboratory or production line.

Best SWR in industry

No other 40-GHz power sensor with K (2.92 mm) connector offers the excellent SWR of NRV-Z55. Especially in the microwave range, where DUTs are normally highly reflective, a well-matched power sensor is the key to reliable measurements. For illustration, let us assume an output with 2.0 source SWR and that its power is measured into 50 Ω at 1.60 sensor SWR which is typical of many 40-GHz power sensors. Mismatch will be the most dominant source of error and contribute as much as 0.67 dB to the overall measurement uncertainty. NRV-Z55 will cut this value by half.

Accurate calibration and traceability

Each Power Sensor of the NRV-Z series is individually cali-

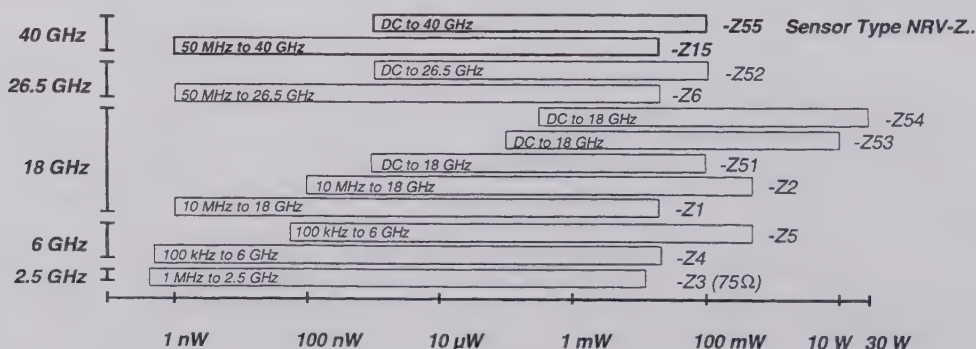
brated with high accuracy so that residual uncertainties often can be neglected. Absolute accuracy is maintained at the highest possible level. For this purpose all power references used in production of the sensors are directly calibrated to the national standards of the Federal German Bureau of Standards (PTB), ensuring minimum loss of accuracy due to transfer of power.

K (2.92 mm) connector for universal use

Both 40-GHz power sensors come with the popular K connector that ensures compatibility with PC3.5 and SMA interfaces, reducing the risk of damage to the connector while maintaining good accuracy without the use of adapters.

All in all the new 40-GHz power sensors are precise, extremely easy-to-operate and highly cost-effective units: plug in the sensors, and they are all ready for your measurement.

Full line of R&S average and CW power sensors



40-GHz Power Sensors NRV-Z55, NRV-Z15

Technical Information

Specifications

	NRV-Z55	NRV-Z15
Power meas. range	1 μ W to 100 mW	1 nW to 20 mW
Max. power	300 mW (avg), 10 W (peak, 1 μ s)	100 mW (avg) 100 mW (peak)
Frequency range	DC to 40 GHz	50 MHz to 40 GHz
Impedance	50 Ω	
Max. SWR (reflection coefficient)		
DC to 2 GHz	1.10 (0.048)	1.15 (0.070)
2 to 4 GHz	1.15 (0.070)	1.15 (0.070)
4 to 12.4 GHz	1.15 (0.070)	1.37 (0.157)
12.4 to 18 GHz	1.20 (0.091)	1.37 (0.157)
18 to 26.5 GHz	1.25 (0.111)	1.37 (0.157)
26.5 to 40 GHz	1.30 (0.130)	1.37 (0.157)
Calibration uncertainty ¹		
0.05 to 2 GHz ²	1.2 %	1.5 %
3 to 4 GHz	1.7 %	1.8 %
5 to 12.4 GHz	2.7 %	4.0 %
13 to 18 GHz	3.5 %	4.4 %
19 to 26.5 GHz	2.7 %	3.1 %
27 to 34 GHz	2.4 %	2.7 %
35 to 40 GHz	2.4 %	2.5 %
Zero offset ³	± 60 nW	± 200 pW
Meter noise ⁴	22 nW	80 pW
Nonlinearity ⁵	± 0.5 %	± 0.5 %
Temperature effect ⁶		
22 to 24°C	0% ⁷	0% ⁷
18 to 28°C	0.4 (0.1)%	0.6 (0.1)%
10 to 40°C	1.3 (0.4)%	2.0 (0.5)%
0 to 50°C	2.0 (0.5)%	4.0 (1.0)%
RF connector	K (2.92 mm) male	
Temperature range	0°C to +50°C (operating), -40°C to 70°C (storage)	
Other environmental specifications	see URV35, URV55, NRVS and NRVD data sheets	
Dimensions	120 mm x 37 mm x 31 mm	
Weight	0.35 kg	
Length of connecting cable	1.3 m (other lengths on request)	

Order designation

Thermal Power Sensor	NRV-Z55	1081.2005.02
Diode Power Sensor	NRV-Z15	1081.2305.02

1 Characteristics

1.1 Application

Power sensors NRV-Z51, NRV-Z52 and NRV-Z55 are thermal power sensors for basic instruments NRVS, NRVD, URV35 and URV55. They permit power measurement from 1 μ W to 100 mW within the frequency ranges DC ... 18 GHz (NRV-Z51), DC ... 26.5 GHz (NRV-Z52) or DC ... 40 GHz (NRV-Z55) in systems having a characteristic impedance of 50 Ω .

The thermal conversion principle always permits measurements of the RMS value independently of the waveform and modulation of the test signal. Depending on whether the measured value is output as a power and/or a power level or as a voltage, the average power (and/or the equivalent power level) or the RMS value of the voltage is displayed.

All measuring heads are d.c. coupled so that even power in the audio-frequency range can be measured.

1.2 Design and Functioning

The power sensor contains a thermo-electric transducer made of silicon by means of semiconductor technology. Due to the power supplied, the 50- Ω termination situated on it heats up. Immediately next to this resistor there is a thermoelement generating a direct voltage proportional to the heating. As termination and thermoelement are dc-decoupled, the power sensors do not contain coupling capacitors. This means that even d.c. powers can be measured, and there is no lower cut-off frequency below which matching and frequency response deteriorate again.

The direct voltage generated by the thermoelement is amplified by a low-noise amplifier of high sensitivity within the sensor and supplied to the basic unit for further processing.

All power sensors contain a data storage in which the parameters obtained during calibration in production are stored in a non-volatile memory. The basic instrument reads out these data and takes account of them when indicating the power measured.

Linearity correction of the measured values is effected automatically with the aid of the correction coefficients stored. For temperature correction, the temperature of the measuring head is evaluated additionally via a temperature sensor. For measurements with frequency response correction, the measuring frequency must be entered via keyboard, remote control interface or an analog control input.

2 Preparation for Use

The measuring head is connected to the basic unit by inserting the plug-in adapter into the opening of the basic unit and locking it into position. This can be done with the unit being switched off or on. Each turn on of the basic unit with the measuring head connected or connecting the measuring head to the basic unit when it is switched on results in the calibration data being read out from the data memory of the measuring head.

Notes for Operation:

- ▶ Maximum input power 100 mW
- ▶ Ambient temperature 0 ... 50 °C
- ▶ Connect RF connection to the signal source only by hand and without fitting it askew
- ▶ Avoid condensation. Should condensation occur nevertheless, the power sensor is to be dried before switching on the unit.
- ▶ Overloading up to 300 mW is permissible, however, the power is not indicated any more.
- ▶ When measuring power below 300 μ W, let sensor warm up (approx. 10 min), avoid heating up of the measuring head due to heated RF connections of the signal source.
- ▶ Calibration applies to power at the RF connector of the power sensor. Adapters situated between sensor and signal source result in additional attenuation and measuring errors due to worse matching with higher frequencies.

3 Operation

3.1 Measuring by means of Power Sensors NRV-Z51, NRV-Z52 and NRV-Z55

3.1.1 Power and Voltage Measurement

Thermal power meters measure the arithmetic mean value of the product of the instantaneous values of voltage and current. This exactly corresponds to the definition of electric true power.

$$P = \frac{1}{T} \int_0^T u \cdot i \cdot dt$$

This means that in the entire control range always the actual true power is measured independently of the waveform of the signal.

If a voltage display is selected at the basic unit, the voltage is calculated from the power measured:

$$U = \sqrt{P \cdot Z_0} \quad (Z_0 = 50 \, \Omega \text{ for NRV-Z51/-Z52/-Z55})$$

V is calculated as the RMS value of a sinusoidal voltage generating the power P at the effective resistance Z_0 .

3.1.2 Power Measuring Ranges

The entire measuring range is divided up into five subranges with power sensors NRV-Z51/-Z52/-Z55:

0 ... 10 μ W

10 ... 100 μ W

0,1 ... 1 mW

1 ... 10 mW

10 ... 100 mW

Basic instruments NRVD and NRVS allow measurement using automatic or manual range selection.

Using automatic range selection (AUTO RANGE) the unit itself sets the suitable measuring range depending on the test level. In the case of manual range selection (FIX RANGE) the user can set a fixed measuring range. Thus the automatic resetting of the most sensitive measuring range with each temporary taking away the measured power can be prevented.

3.1.3 Measurement Rate and Noise

The smaller the test signal, the greater the effect of noise inevitably occurring in electronic circuits. It results in fluctuations of the indicated value. In order to achieve a high measuring accuracy, a filtering of the test signal is necessary. However, the more effective this filtering has to be, the more the measuring rate decreases.

Basic units NRVD and NRVS offer the possibility of measuring by means of automatic or manual filter setting.

With automatic filter setting it is guaranteed that the optimal filter is set depending on the measuring range and the display resolution the user has selected. The measuring rate results from filter setting. Very small test signals (that is to say, a low measuring range) and a high display resolution require the most effective filtering and thus result in the smallest measuring rate.

If automatic filter selection does not seem to be optimally adapted to a specific measurement, that is to say, e.g., a higher measurement rate (deteriorating display noise) is demanded, another filter can be set manually.

The connection between filter number, measuring period and noise can be taken from the Specifications.

3.1.4 Zeroing

When measuring low power, an additive offset - of positive or negative polarity -, as it results, e.g., due to thermo-electromotive force at the measuring head, can invalidate the measurement result. In zeroing the offset is measured, stored and subtracted from the following measured values.

Notes for Zeroing

- ▶ No power to be measured must be applied to the measuring head.
- ▶ After measuring large powers, wait until the indicated value has become stable before starting zeroing.
- ▶ Do not move the sensor cable to a large extent during zeroing.
- ▶ In the case of changing ambient temperatures or when the instrument has not yet warmed up completely, check zeroing without a power to be measured applied from time to time and repeat if necessary.
- ▶ Ground loops can result in external offsets. If these cannot be completely eliminated by means of correct grounding, the sensor remains connected to the signal generator (with the power to be measured switched off) also during zeroing. In doing so, the external offset is recorded as well and considered in calculating the indicated value.
- ▶ The zero offset is not stored after switching off the instrument. Thus it should be carried out after each switching on.

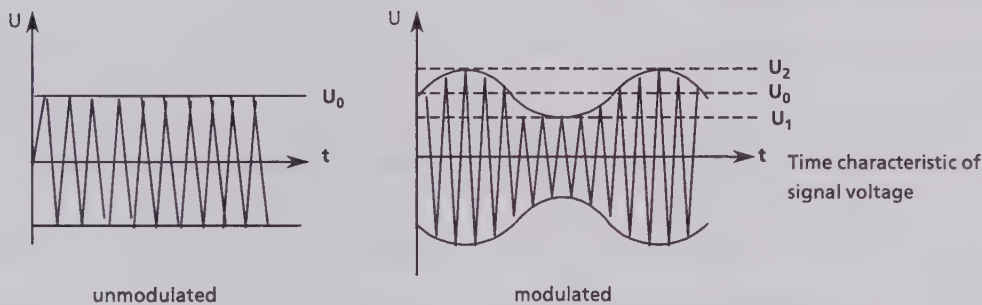
3.1.5 Frequency Response Correction

The frequency response of every power sensor is individually measured in calibrating and stored as a calibration factor (ratio of indicated power to power supplied) in the data memory of the sensor for a plurality of frequencies. Frequency response correction is considered by entering the test frequency into the basic unit. If the frequency entered is between two calibration frequencies, the respective calibration factor is calculated by means of linear interpolation. For power sensors NRV-Z51/-Z52/-Z55 the calibration factors refer to the sensor sensitivity at 50 MHz. If measurement is carried out without frequency response correction, the measured value is indicated as if measurement was carried out at 50 MHz.

3.1.6 Measurement of Modulated Signals

The capability of thermal measuring heads of measuring the average power also in the case of arbitrarily modulated signals allows, together with the basic unit NRVD, to determine the modulation depth in the case of amplitude-modulated carriers (only NRVD) and the pulse power with pulse-modulated RF (NRVD, NRVS, URV55).

Determination of Modulation Depth:



Modulation depth is calculated from:

$$m = \frac{(U_2 - U_1)/2}{U_0}$$

In the case of amplitude modulation, two sideband frequencies having the amplitude

$$U = \frac{m}{2} \cdot U_0$$

are formed above and below the carrier frequency, which corresponds to an increase in power.

Unmodulated Power:

$$P_{unmod} = \frac{U_0^2}{Z_0}$$

Modulated Power:

$$P_{mod} = \frac{U_0^2}{Z_0} + 2 \cdot \frac{(U_0 \cdot m/2)^2}{Z_0} = P_{unmod} \cdot \left(1 + \frac{m^2}{2}\right)$$

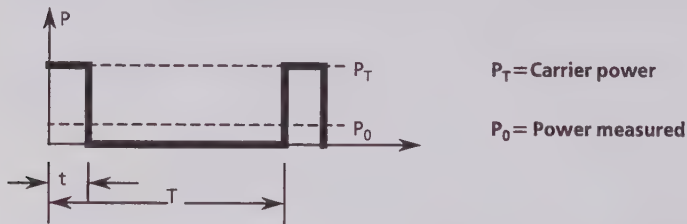
From the power measured using modulation or not, the modulation depth is calculated:

$$m = \sqrt{2 \cdot (P_{mod}/P_{unmod} - 1)}$$

In order to measure the modulation depth exactly it is necessary for the carrier mean value V_0 to remain constant in modulation and for the modulation to be exactly sinusoidal.

Measurement of pulse-modulated power:

The carrier power can be calculated from the pulse duty factor (Duty Cycle) with pulse-modulated signals. To distinguish it from the maximum envelope power to be measured physically (PEP) this value is designated as pulse power.



For calculating the carrier power it is taken for granted that the energy of the average power P_0 measured during the time T is as large as the energy of carrier power P_T during the time t :

$$P_0 \cdot T = P_T \cdot t$$

$$P_T = \frac{T}{t} \cdot P_0$$

When measuring modulated signals, it has to be noted that the thermal power sensors contain a chopper amplifier whose chopping frequency is approx. 575 Hz. Modulation using this frequency, half, two or three times the value, can result in periodic display variations. In this case the modulation frequency should be slightly varied.

3.2 Measuring Accuracy

Every measurement will inevitably have measuring errors of various causes. The error value actually resulting in any measurement is almost never known. It is only possible to indicate the possible maximal values of the individual errors and calculate limits from these between which the total error can be.

3.2.1 Mismatch

Thermal sensors NRV-Z51/-Z52/-Z55 serve to measure the power a source can supply to a load having the ohmic resistance Z_0 . In general, however, the impedance of the source as well as the impedance of the power sensor acting as a load are different from the value Z_0 . The error in the power measured resulting from this mutual mismatch is calculated from:

$$E_p = \frac{1 - |\Gamma_l|^2}{|1 - \Gamma_g \cdot \Gamma_l|^2} - 1$$

Γ_g : complex reflection coefficient of the source
 Γ_l : complex reflection coefficient of the load

The numerator $1 - |\Gamma_l|^2$ in the above equation results in a fraction defective which is only caused by the load. It is determined by measurement during calibration with the power sensors and is included in the calibration factor (see Section 3.2.2).

A second fraction defective is caused by the denominator $|1 - \Gamma_g \cdot \Gamma_l|^2$. As Γ_l and Γ_g are complex a.c. parameters, the error can become positive or negative depending on their phasing. In general, the amount and phase of reflection coefficient Γ_g of the source are not known, thus the size of this error cannot be indicated in the data sheet and not be calculated in practice either.

However, the error limits can be determined from the maximal values of the amounts of the reflection coefficients. The mismatch uncertainty M_u resulting from mismatch between source and load is calculated in percent of the power:

$$M_u [\%] = 100 \cdot [(1 \pm r_g \cdot r_l)^2 - 1]$$

By approximation, the following is true:

$$M_u [\%] \approx \pm 200 \cdot r_g \cdot r_l$$

r_g : Amount of reflection coefficient of the source
 r_l : Amount of reflection coefficient of the load

3.2.2 Calibration Uncertainty

Due to the fact that the reflection coefficient of a power sensor is inevitably larger than zero (and its $SWR > 1$), part of the power offered to the sensor is reflected. Hence all power sensors are individually measured at a plurality of calibration frequencies during production. The power measured is compared with the one supplied by the calibration system and the relation of both values is stored as calibration factor. When frequency response correction is switched on, the measurement result is set off against the calibration factor belonging to the measuring frequency entered.

All measuring systems for calibrating power sensors used by R&S can be traced to the corresponding primary standards by the Physikalisch-Technische Bundesanstalt PTB (Federal Office for Weights and Measures).

In spite of this, even the determination of the calibration factor includes mismatch uncertainties resulting from mismatch, errors in transmitting power and the mismatch uncertainty of PTB primary standards. The error limits of the calibration factor are - depending on the frequency and the respective sensor - indicated as RSS error in the data sheet (see Section 3.2.7).

3.2.3 Linearity Error

An ideal power meter is expected to show a strictly proportional connection between the measured power applied and the measured power indicated over the entire measuring range. The behaviour of real power meters is more or less different from this ideal behaviour, the result is a linearity error which depends on the control.

In the case of the thermal power sensors, the linearity error is very small, because the control characteristic of each sensor is individually measured in production and stored in the non-volatile data memory of the sensor. On the basis of these data, the power indicated by the basic unit is mathematically corrected to result in an almost perfect linearization. The remaining residual error is specified in the Specifications of the power sensors.

3.2.4 Display Noise

The noise superimposed on the output signal generated by the power sensor causes slight variations of the indicated value which result in a measuring error. As the build-up of noise is a statistic process, it is useful to describe the amount of noise using the methods of probability calculus.

R&S states twice the value of the standard deviation for noise power. This means that this value of the noise power is not exceeded in 95% of a statistically sufficiently large number of measurements.

Display noise is an additive value, i.e. the error caused by noise becomes the smaller, the larger the power measured is.

The value of display noise can be influenced by the filter setting (see Section 3.1.3): Each additional doubling in averaging reduces the display noise power by approx. 30%.

3.2.5 Zero Error

A zero error is induced when a power different from zero is displayed without a power measured. Most of the time variations in temperature the measuring head is subjected to are the cause of this offset. In zeroing (see Section 3.1.4) the offset is measured and subtracted from the measured value in the successive measurement.

Zero error as well is an additive value whose error effect becomes the smaller, the larger the power measured is. When measuring small power, it is thus recommended to keep variations in temperature, as they can be induced by the warmth of the hand imparted to the measuring head or heated RF connections of signal generators, small and to repeat zero adjustment from time to time.

3.2.6 Temperature Effect

The temperature effect is an additional error resulting at a temperature which is constant but other than 23 °C.

By means of cyclic temperature measurement, the influence of changing ambient temperatures can be mathematically corrected up to a very small residual error with the aid of the thermal characteristic stored. It is approx. 0.1 %/grd, with respect to a calibration temperature of 23 °C.

3.2.7 Errors of the Basic Unit

The analog unit of the basic instruments basically consists of a precise DC amplifier and a high-resolution A/D converter. The error indicated is only caused by the drift of gain factors (time, temperature) and, like all other errors, refers to the measured value. As the typical error is still substantially smaller in general, the error of the basic instrument can be neglected compared to the other mismatch uncertainties.

3.2.8 Maximum and RSS Error

A correct error indication must contain two pieces of information:

- How large are the error limits and
- how large is the confidence level, i.e. how many measuring results out of a large number of measurements do not exceed the error limits.

In the case of the maximum error the confidence level is 100 %: The error limits are exceeded in no measurement. The maximum error E_{max} is the sum of all individual maximum errors $(E_{max})_i$:

$$E_{max} = \sum_{i=1}^N (E_{max})_i$$

In practice, one sees that the maximum error is only rarely achieved. If the total error is composed of many individual errors which have causes independent of each other (and this is the case with the individual errors described up to now), it is, statistically, a very rare event that all individual errors occur with their maximal value and same sign at the same time in a measurement.

In power measurement it has thus become customary to state the RSS error (RSS: Root Sum of the Squares), which is closer to practice.

It is the square root of the sum of the squares of the individual RSS errors $(E_{RSS})_i$:

$$E_{RSS} = \sqrt{\sum_{i=1}^N (E_{RSS})_i^2}$$

The RSS error of a sum of individual errors is the error which is generally not exceeded in 95 % of all measurement results.

3.2.9 Total Mismatch Uncertainty

The total mismatch uncertainty is calculated (as an RSS value) by an example under the following measurement conditions:

- Power sensor NRV-Z51
- Power measured 5 mW
- Frequency 6.5 GHz
- Ambient temperature 24 °C
- SWR of source 1.35 ($r=0.15$)
- NRVD filter 4

The following example shows that the greatest individual error is caused due to mismatch between source and measuring head. The measuring accuracy can thus be increased most lastingly by means of better SWR values of the source.

Cause of Error	Description in Section	Indiv. Error (RSS) in %
Matching $r_g = 0.15$ $r_l = 0.07$	3.2.1	2.1
Cal. uncertainty	3.2.2	1.3
Linearity	3.2.3	0.3
Zero $\pm 60 \text{ nW}$	3.2.5	≈ 0
Noise $\pm 240 \text{ nW}$	3.2.4	≈ 0
Basic instrument NRVD	3.2.7	0.3
Temperature	3.2.6	0.1
RSS total mismatch uncertainty		$\pm 2.51 \%$

4 Maintenance and Troubleshooting

4.1 Maintenance

Power sensors NRV-Z51/-Z52/-Z55 are maintenance-free. The RF plug should be cleaned from time to time. Sticking dirt can be removed by means of a pencil and alcohol.

4.2 Troubleshooting

Troubleshooting can only be limited to the clarification of whether a power sensor is defective. Repair requires a new calibration in almost all cases, which must be carried out by the manufacturer.

If the rated values of the following tests are not observed, the measuring head is defective and should be had repaired.

4.2.1 Testing Sensor Sensitivity

Test Setup:

- ▶ Directly connect power sensor (without RF cable) to the testing generator of the NRVD. Enter 50 MHz correction frequency at the NRVD, carry out zero adjustment, switch on testing generator.

Rated Value of Power Readout:

- ▶ 0.98 ... 1.02 mW (18 ... 23 °C)

4.2.2 Testing SWR

Test Setup:

- ▶ Directly connect power sensor (without RF cable) to an SWR network analyzer.
The measurement inaccuracy of the network analyzer has to be taken into account for the measured SWR value.

Rated Values SWR:

Frequency	Maximum SWR (r)
DC...2 GHz	1.1 (0.048)
2...12.4 GHz	1.15 (0.07)
12.4...18 GHz	1.2 (0.09)
18...26.5 GHz (NRV-Z52, NRV-Z55)	1.25 (0.11)
26.5...40 GHz (only NRV-Z55)	1.30 (0.13)

5 Checking Rated Specifications

Due to the multifarious sources of error, power and reflection measurements in the frequency range of up to 40 GHz require a large amount of apparatus, experience and special care.

A remeasurement of the characteristics guaranteed in the Specifications should thus only be carried out with appropriate calibrating facilities or in the service shops of R&S.

For the power sensors NRV-Z51, NRV-Z52 and NRV-Z55 an annual check, if necessary including calibration, with the manufacturer is recommended.

**Schaltteillisten
numerisch geordnet**

**Part lists
in numerical order**

**Listes des pièces détachées
par numéros de référence**

Kennz. Comp. No.	Benennung Designation	Sachnummer Stock No.	Hersteller Manufacturer	Bezeichnung Designation	enthalten in contained in
.	XX VARIANTENERKLÄRUNG IDENTIFICATION OF MODELS VAR 02 = GRUNDAUSFÜHRUNG MOD 02 = BASIC MODEL XX ZÜGEH.STROML. CIRC.DIAGR. 857.9004 S				
A1	ED DATENSPEICHER II MEMORY II NUR VAR/ONLY MOD: 02 HIERZU STROML.395.3040S SEE CIRC.DIAGR.395.3040S	0395.3040.02			0828.4537.01
A1	ED DATENSPEICHER III NUR VAR/ONLY MOD: 03 13 HIERZU STROML. 395.3063 S SEE CIRC.DIAGR. 395.3063 S	0395.3063.02			0828.4537.01
A1	ED DATENSPEICHER II MEMORY II NUR VAR/ONLY MOD: 42	0395.3040.42			0828.4537.01
A2	ED MESSKOPFVERSTÄRKER PROBE AMPLIFIER NUR VAR/ONLY MOD: 02 03 HIERZU STROML.828.4750S SEE CIRC.DIAGR.828.4750S	0828.4750.02			0828.4537.01
A2	ED ANSCHLUSSPLATTE NUR VAR/ONLY MOD: 13 HIERZU STROML. 1028.2486 S SEE CIRC.DIAGR.1028.2886 S	1081.2486.02			0828.4537.01
A2	ED MESSKOPFVERSTÄRKER PROBE AMPLIFIER NUR VAR/ONLY MOD: 42 HIERZU STROML. 828.4750 S SEE CIRC.DIAGR. 828.4750 S	0828.4750.42			0828.4537.01
A3	ZE DETECTOR(NRV-Z51) 18 GHZ DETECTOR	0857.9040.00			
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 02	0852.7032.02			0828.4537.01
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 03 13	0395.1090.02			0828.4537.01
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 42	0852.7032.42			0828.4537.01
X1	FJ STECKERKOPF N PRAEZ. CONNECTOR	0857.9091.00	ROSENBERGE	05S-121-000-S2 (S3)	0857.9040.00

1GPK	587	3PUA	ÄI	Datum Date	Schaltteilliste für Parts list for	Sachnummer Stock No.	Blatt-Nr. Page
	09	18.06.98		GG NRV-Z51 MESSKOPF		0857.9004.01 SA	1-

Kennz. Comp. No.	Benennung Designation	Sachnummer Stock No.	Hersteller Manufacturer	Bezeichnung Designation	enthalten in contained in
.	XX VARIANTENERKLAERUNG IDENTIFICATION OF MODELS VAR 02 = GRUNDAUSFUEHRUNG MOD 02 = BASIC MODEL XX ZUEGH.STROML. CIRC.DIAGR. 857.9204 S				
A1	ED DATENSPEICHER II MEMORY II NUR VAR/ONLY MOD: 02 HIERZU STROML.395.3040S SEE CIRC.DIAGR.395.3040S	0395.3040.02			0828.4537.01
A1	ED DATENSPEICHER III NUR VAR/ONLY MOD: 03 13 HIERZU STROML. 395.3063 S SEE CIRC.DIAGR. 395.3063 S	0395.3063.02			0828.4537.01
A1	ED DATENSPEICHER II MEMORY II NUR VAR/ONLY MOD: 42	0395.3040.42			0828.4537.01
A2	ED MESSKOPFVERSTAERKER PROBE AMPLIFIER NUR VAR/ONLY MOD: 02 03 HIERZU STROML.828.4750S SEE CIRC.DIAGR.828.4750S	0828.4750.02			0828.4537.01
A2	ED ANSCHLUSSPLATTE NUR VAR/ONLY MOD: 13 HIERZU STROML. 1028.2486 S SEE CIRC.DIAGR.1028.2886 S	1081.2486.02			0828.4537.01
A2	ED MESSKOPFVERSTAERKER PROBE AMPLIFIER NUR VAR/ONLY MOD: 42 HIERZU STROML. 828.4750 S SEE CIRC.DIAGR. 828.4750 S	0828.4750.42			0828.4537.01
A3	ZE DETECTOR 26,5 GHZ 26,5 GHZ DETECTOR	0857.9240.00			
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 02	0852.7032.02			0828.4537.01
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 03 13	0395.1090.02			0828.4537.01
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 42	0852.7032.42			0828.4537.01
X1	FJ STECKERKOPF SYST.PC3,5 CONNECTOR	0857.9291.00	AMPHENOL	131-7001	0857.9240.00

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Date

Schaltteilliste für
Parts list for

Sachnummer
Stock No.

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1-

Kennz. Comp. No.	Benennung Designation	Sachnummer Stock No.	Hersteller Manufacturer	Bezeichnung Designation	enthalten in contained in
A1	ED DATENSPEICHER II MEMORY II NUR VAR/ONLY MOD: 02 HIERZU STROML. 395.3040S SEE CIRC.DIAGR. 395.3040S	0395.3040.02			0828.4537.01
A1	ED DATENSPEICHER III NUR VAR/ONLY MOD: 03 13 HIERZU STROML. 395.3063 S SEE CIRC.DIAGR. 395.3063 S	0395.3063.02			0828.4537.01
A1	ED DATENSPEICHER II MEMORY II NUR VAR/ONLY MOD: 42	0395.3040.42			0828.4537.01
A2	ED MESSKOPFVERSTAERKER PROBE AMPLIFIER NUR VAR/ONLY MOD: 02 03 HIERZU STROML. 828.4750S SEE CIRC.DIAGR. 828.4750S	0828.4750.02			0828.4537.01
A2	ED ANSCHLUSSPLATTE NUR VAR/ONLY MOD: 13 HIERZU STROML. 1028.2486 S SEE CIRC.DIAGR. 1028.2886 S	1081.2486.02			0828.4537.01
A2	ED MESSKOPFVERSTAERKER PROBE AMPLIFIER NUR VAR/ONLY MOD: 42 HIERZU STROML. 828.4750 S SEE CIRC.DIAGR. 828.4750 S	0828.4750.42			0828.4537.01
A3	ZE DETEKTORGRUPPE	1081.2070.02			
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 02	0852.7032.02			0828.4537.01
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 03 13	0395.1090.02			0828.4537.01
W1	DX KABEL CABLE NUR VAR/ONLY MOD: 42	0852.7032.42			0828.4537.01

1GPK	587 3PUA	Äi	Datum Date	Schaltteilliste für Parts list for	Sachnummer Stock No.	Blatt-Nr. Page
 ROHDE & SCHWARZ	01	18.06.98	GG NRV-Z55 40GHZ-THERM.MK	1081.2005.01 SA	1-	

Kennz. Comp. No.	Benennung Designation	Sachnummer Stock No.	Hersteller Manufacturer	Bezeichnung Designation	enthalten in contained in
	XX VARIANTENERKLAERUNG IDENTIFICATION OF MODELS VARO2=GRUNDAUSFUEHRUNG MODO2=BASIC_MODEL				
C1 ..3	CC 470NF+-10%50V X7R 1812 CERAMIC CHIP CAPACITOR	CC 0007.7498.00	AVX	1812 5C 474KA TOOF	
C4 ..6	CC 33NF+-10% 25V HDK 0603 CERAMIC CHIP CAPACITOR	1051.4697.00	AVX	CM105X7R333K25VAT	
C7	CC 47PF+-1% 50VNPO 0603 SMD-CERAMIC-CAPACITOR	CC 0009.4644.00	MURATA	GRM39COG***F50PT	
C8	CC 47PF+-1% 50VNPO 0603 SMD-CERAMIC-CAPACITOR	CC 0009.4644.00	MURATA	GRM39COG***F50PT	
C9	CC 1,0NF+-10%50V HDK 0603 SMD-CERAMIC-CAPACITOR	CC 0009.4938.00	MURATA	GRM39X7R***K5C500PT*	
D1	BC N28F010 128KX8FL.EPROM FLASH-EPROM	0007.9861.00	AMD	AM28F010-150JC	
D2	BG TH3063.1I MEKOLO ASIC IC GATEARRAY	0857.8350.00	THESYS	TH3063.1I	
N1	BO LP2951CMLWDROP +VREGL IC VOLTAGE REGULATOR	1020.0890.00	NSC	LP2951CM	
P1	VL EINPRESSTIFT L=6,8 PIN NICHT BESTUECKT NOT FITTED	VL 0010.7250.00	AMP	1-928776-5	
P2	VL EINPRESSTIFT L=6,8 PIN NICHT BESTUECKT NOT FITTED	VL 0010.7250.00	AMP	1-928776-5	
R1	RG 10K +-1% TK200 0603 SMD-RESISTOR EIA0603	RG 0009.5357.00	DRALORIC	CR 0603	
R2 ..5	RG 825R +-1% TK200 0603 SMD-RESISTOR EIA0603	0010.8391.00	ROEDERSTEI	D11 0603	
R6	RG 1K0 +-1% TK200 0603 SMD-RESISTOR EIA0603	RG 0009.5340.00	DRALORIC	CR 0603	
R7 ..13	RG 100K +-1% TK200 0603 SMD RESISTOR	RG 0009.5363.00	DRALORIC	CR 0603	
R14	RG 2K2 +-1% TK200 0603 SMD-RESISTOR EIA0603	0009.7008.00	DRALORIC	CR 0603	
S1	SK CODIERSCH..2P.2XEIN DIP-SWITCH	1081.0190.00	C&K	DMR-02-T(R)	
S2	SK CODIERSCH..2P.2XEIN DIP-SWITCH	1081.0190.00	C&K	DMR-02-T(R)	
V1	AE BZV55/C15 0,5W ZDI ZENER DIODE	AE 0006.9900.00	PHILIPS_SE	BZV55B15	
V2	AK BC860B P 45V 200MA TRANSISTOR	AK 0007.7975.00	MOTOROLA	BC860B	
V3	AM SI9948DY P-E DUAL MOSF DUAL P-CH E-MODE MOSFET	0395.1525.00	SILICONIX	SI 9948 DY	
V4	AK BC860B P 45V 200MA TRANSISTOR	AK 0007.7975.00	MOTOROLA	BC860B	
V7	AE BZV55/C6V2 0,5W ZDI ZENER DIODE	AE 0006.9851.00	PHILIPS	BZV55B6V2	
V8	AE BZV55/C7V5 0,5W ZDI ZENER DIODE	AE 0007.3428.00	PHILIPS_SE	BZV55B7V5	
X1	FP STIFTELEISTE 8POL.WINK. CONNECTOR	1081.1750.00	LACON	070-51-03-128-008	
X10	FP IND.STECKERLEISTE 12P. CONNECTOR	0516.0200.00	BINDER	10-9839-00-12	

1GPK	587	3PUA	ÄI	Datum Date	Schaltteilliste für Parts list for	Sachnummer Stock No.	Blatt-Nr. Page
 ROHDE & SCHWARZ				02	18.06.98	ED DATENSPEICHER III	0395.3063.01 SA
							1-

Kennz. Comp. No.	Benennung Designation	Sachnummer Stock No.	Hersteller Manufacturer	Bezeichnung Designation	enthalten in contained in														
C1	CK 2,2UF+-10%50V L7B5H10 FILM CAPACITOR	0828.4789.00	WESTERMANN	MKS 22															
C2	CE 47UF+-20%10V6RD6,3X5 ELECTROLYTIC CAPACITOR	0377.0308.00	NAT_PANASO	ECEA1AKS470															
C3	CC 220NF+-10%50V X7R 1210 CERAMIC CAPACITOR CHIP	CC 0520.6850.00	AVX	1210 5C 224KA 11A															
C4	CE 22UF+-20%16V5RDX5RAD.A ELECTROLYTIC CAPACITOR	0358.6062.00	NAT_PANASO	ECE A 1C KS 220 B															
C5	CC 1,8NF+-1% 50V NPO 1206 CERAMIC CHIP CAPACITOR	CC 0007.7423.00	PHILIPS_CO	2222 863 18182															
C6	CC 100NF+-10%50V X7R 1206 CERAMIC CHIP CAPACITOR	CC 0007.5237.00	PHILIPS_CO	2238 581 55649															
C7	CC 100NF+-10%50V X7R 1206 CERAMIC CHIP CAPACITOR	CC 0007.5237.00	PHILIPS_CO	2238 581 55649															
C8	CK 470NF+-5%63V RD5H10MKT CAPACITOR	CK 0099.2975.00	ROEDERSTEI	MKT 1826-447-06-4															
C9	CE 10UF +-10% 25V 7343 TANTALUM SMD-CAPACITOR	CE 0007.7246.00	KEMET	T491D106K025AS															
C10	CE 10UF +-10% 25V 7343 TANTALUM SMD-CAPACITOR	CE 0007.7246.00	KEMET	T491D106K025AS															
C11	CE 1UF +-10% 10V 1206 TANTALUM-SMD-CAPACITOR NICHT BESTUECKT/NOT FITTED	CE 0007.7252.00	KEMET	T491 A 105 K 010 AS															
C12	CC 100NF+-10%50V X7R 1206 CERAMIC CHIP CAPACITOR	CC 0007.5237.00	PHILIPS_CO	2238 581 55649															
C13	CK 2,2UF+-10%50V L7B5H10 FILM CAPACITOR	0828.4789.00	WESTERMANN	MKS 22															
D1	BL HEF4047BT MONO/AST MV MULTIFIBRATOR	0350.4102.00	PHILIPS_SE	HEF4047BT															
L1 ..6	LD T-FILTER 3,3NF SMD SMD-FILTER	1039.1362.00	MURATA	NFM61R20T332T1															
N1	B0 LT1078 LP 2X OPAMP IC DUAL OPAMP	0828.4795.00	LINEAR_TEC	LT1078S8															
N2	B0 LT1077S8 LP OPAMP OPAMP	0828.4714.00	LINEAR_TEC	LT1077(S8)															
P1	VL EINPRESSTIFT L=6,8 PIN	VL 0010.7250.00	AMP	1-928776-5															
R1	RG 475 OHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5695.00	ROEDERSTEI	D25															
R2	RG 22,1KOHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5872.00	ROEDERSTEI	D25															
R3	RG 47,5KOHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5950.00	ROEDERSTEI	D25															
R4	RG 47,5 OHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5566.00	ROEDERSTEI	D25															
R5	RG 56,2KOHM+-1%TK100 1206 CHIP RESISTOR	RG 0007.1883.00	ROEDERSTEI	D25															
R6	RG 56,2KOHM+-1%TK100 1206 CHIP RESISTOR	RG 0007.1883.00	ROEDERSTEI	D25															
R7	RG 100,0KOH+-1%TK100 1206 CHIP RESISTOR	RG 0007.1948.00	ROEDERSTEI	D25															
R8	RG 100,0KOH+-1%TK100 1206 CHIP RESISTOR	RG 0007.1948.00	ROEDERSTEI	D25															
R9	RG 10,0KOHM+-1%TK100 1206 RG CHIP RESISTOR	RG 0007.0793.00	PHILIPS_CO	RC02															
R10	RG 100,0KOH+-1%TK100 1206 CHIP RESISTOR	RG 0007.1948.00	ROEDERSTEI	D25															
R11	RG 24,3KOHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5889.00	ROEDERSTEI	D25															
R12	RG 15,0KOHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5843.00	ROEDERSTEI	D25															
R13 ..15	RG 182 OHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5595.00	ROEDERSTEI	D25															
R16	RG 200 KOHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5995.00	ROEDERSTEI	D25															
R17	RS 0,25W100KOHM+-20% SMD POTENTIOMETER	RS 0007.9678.00	BOURNS	3314G--1-															
R18	RG 22K +-1% TK200 0603 SMD-RESISTOR EIA0603	0009.7050.00	DRALORIC	CR 0603															
R19	RG 33K +-1% TK200 0603 SMD-RESISTOR EIA0603	0009.7066.00	DRALORIC	CR 0603															
R20	RG 10,0KOHM+-1%TK100 1206 RG CHIP RESISTOR	RG 0007.0793.00	PHILIPS_CO	RC02															
<table><tr><td>1GPK</td><td>587 3PUA</td><td>ÄI</td><td>Datum Date</td><td>Schaltteilliste für Parts list for</td><td>Sachnummer Stock No.</td><td>Blatt-Nr. Page</td></tr><tr><td colspan="3"> ROHDE & SCHWARZ</td><td>04 18.06.98</td><td>ED MESSKOPFVERSTAERKER PROBE AMPLIFIER</td><td>0828.4750.01 SA</td><td>1+</td></tr></table>						1GPK	587 3PUA	ÄI	Datum Date	Schaltteilliste für Parts list for	Sachnummer Stock No.	Blatt-Nr. Page	 ROHDE & SCHWARZ			04 18.06.98	ED MESSKOPFVERSTAERKER PROBE AMPLIFIER	0828.4750.01 SA	1+
1GPK	587 3PUA	ÄI	Datum Date	Schaltteilliste für Parts list for	Sachnummer Stock No.	Blatt-Nr. Page													
 ROHDE & SCHWARZ			04 18.06.98	ED MESSKOPFVERSTAERKER PROBE AMPLIFIER	0828.4750.01 SA	1+													

Kennz. Comp. No.	Benennung Designation	Sachnummer Stock No.	Hersteller Manufacturer	Bezeichnung Designation	enthalten in contained in
R21	RG 4,75KOHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5820.00	ROEDERSTEI	D25	
R22	RG 47,5 OHM+-1%TK100 1206 RESISTOR CHIP	RG 0007.5566.00	ROEDERSTEI	D25	
V1	AK MMBT4403 P 40V 600MA SWITCHING TRANSISTOR	0828.4720.00	MOTOROLA	MMBT4403	
V2	AM SST441 DUAL JFET DUAL MONOLITIC JFET	0828.4743.00	SILICONIX	SST441	
V3	AM SST4393 35V JFET JFET	0828.4737.00	SILICONIX	SST4393	
X1	FP STIFTFLEISTE 7P. R=2MM CONNECTOR	FP 0852.7155.00	SAMTEC	TMM-107-03-S-S	
X2	XX ENTHALTEN IN INCLUDED IN LAYOUT				
1GPK	587 3PUA	ÄI	Datum Date	Schaltteilliste für Parts list for	Sachnummer Stock No.
 ROHDE & SCHWARZ		04	18.06.98	ED MESSKOPFVERSTÄRKER PROBE AMPLIFIER	0828.4750.01 SA
					Blatt-Nr. Page
					2-



XY-Liste

XY List

Erklärung der Spaltenbezeichnungen:

- Part:** Bauelement-Kennzeichen.
- Side:** Leiterplatten-Seite, auf der sich das Bauelement befindet.
- X/Y:** Koordinaten (Millimeter) des Bauelementes auf der Leiterplatte bezogen auf den Nullpunkt.
- SQR, PG:** Planquadrat und Seite des Schaltbildes für das jeweilige Bauelement.

Explanation of column designations:

- Part:** Identification of instrument part.
- Side:** Side of the PC board on which instrument part is positioned.
- X/Y:** Coordinates (millimeter) of the component on the PC board in reference to zero point.
- SQR, PG:** Square and page of the diagram for the respective instrument part.

Nicht-Service-Relevante Bauteile / Non-Service-Relevant Components																	
Part Side X Y Sqr Pg						Part Side X Y Sqr Pg						Part Side X Y Sqr Pg					
C1	B	23	3	5B	1	P2	B	41	24	5D	1	S1	B	54	20	3D	1
C2	B	12	3	4A	1	R1	B	35	25	5D	1	S1	B	54	20	3D	1
C3	B	7	15	3F	1	R2	B	37	27	2C	1	S2	B	54	27	3C	1
C4	B	10	9	8E	1	R3	B	37	30	2C	1	S2	B	54	27	3D	1
C5	B	10	11	8E	1	R4	B	37	23	2D	1	V1	B	34	8	3B	1
C6	B	10	13	8E	1	R5	B	37	29	2D	1	V2	B	25	8	3A	1
C7	B	1	19	6C	1	R6	B	36	32	5D	1	V3	B	20	9	4B	1
C8	B	1	34	6C	1	R7	B	10	7	8E	1	V3	B	20	9	6A	1
C9	B	37	34	5D	1	R8	B	30	6	3A	1	V4	B	27	11	5B	1
D1	B	8	19	3F	1	R9	B	31	8	3A	1	V7	B	34	12	6B	1
D1	B	8	19	6D	1	R10	B	22	13	5A	1	V8	B	10	16	5C	1
D2	B	25	17	2F	1	R11	B	30	13	6B	1	X1	B	55	15	3E	1
D2	B	25	17	5C	1	R12	B	31	11	6B	1	X10	B	58	4	2E	1
N1	B	20	2	4A	1	R13	B	22	10	3B	1						
P1	B	41	27	5D	1	R14	B	6	10	2E	1						

ROHDE	ÄI	Datum	XY-Liste für	Sach-Nummer	Blatt
&		Date	XY-list for	Stock-Nr	Page
SCHWARZ			ED DATENSPEICHER_III		
	03	14.11.96	MEMORY_III	395.3063.01 XY	1-

Nicht-Service-Relevante Bauteile / Non-Service-Relevant Components																	
Part	Side	X	Y	Sqr	Pg	Part	Side	X	Y	Sqr	Pg	Part	Side	X	Y	Sqr	Pg
C1	B	10	23	2C	1	L5	B	34	7	7D	1	R11	A	26	8	6B	1
C2	B	20	20	4B	1	L6	B	40	22	7E	1	R12	A	34	10	7B	1
C3	A	8	4	3B	1	N1-A	B	25	14	5B	1	R13	B	45	14	8B	1
C4	B	31	6	4C	1	N1-B				6B	1	R14	B	45	6	8D	1
C5	B	16	1	4D	1	N1-C				4E	1	R15	B	47	19	8E	1
C6	A	26	17	5B	1	N2-A	B	22	10	4C	1	R16	B	18	2	4D	1
C7	A	27	4	6B	1	N2-B				4E	1	R17	B	26	1	4D	1
C8	B	28	17	7B	1	P1	B	29	2	3D	1	R18	B	32	14	4D	1
C9	A	24	3	7D	1	R1	A	8	17	2B	1	R19	B	32	11	4D	1
C10	A	40	3	7E	1	R2	A	14	5	3B	1	R20	A	10	8	5C	1
C11	A	3	15	2C	1	R3	A	27	10	4B	1	R21	A	32	14	4D	1
C12	B	9	12	4E	1	R4	A	19	10	4B	1	R22	A	8	7	2D	1
C13	B	15	23	2C	1	R5	A	24	14	4B	1	V1	A	17	8	4B	1
D1	B	13	2	4D	1	R6	A	22	10	4C	1	V2-A	A	17	14	3C	1
L1	B	34	15	7A	1	R7	A	31	17	5B	1	V2-B				3B	1
L2	B	34	17	7A	1	R8	A	23	23	5B	1	V3	B	21	6	5C	1
L3	B	34	12	7B	1	R9	A	23	17	5B	1	X1	B	43	7	8A	1
L4	B	34	10	7C	1	R10	A	29	14	5B	1	X2	B	3	15	1C	1

ROHDE & SCHWARZ	ÄI	Datum Date	XY-Liste für XY-list for	Sach-Nummer Stock-Nr	Blatt Page
	01	31.01.94	ED MESSKOPFVERSTAERKER PROBE_AMPLIFIER	828.4750.01 XY	1-



ROHDE & SCHWARZ

**Stromläufe
Bestückungspläne**

**Circuit diagrams
Component plans**

**Schémas de circuit
Plans des composants**

1

2

3

4

A

B

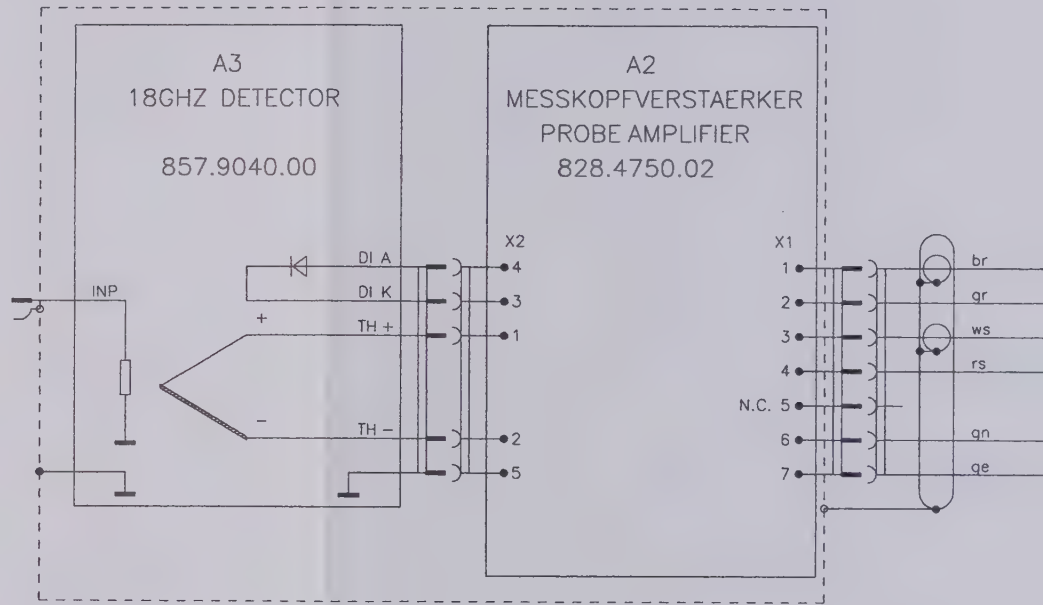
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D

E

F

FUER DIESE UNTERLAGE
BEHALTEN WIR UNS ALLE RECHTE VOR



ROHDE & SCHWARZ

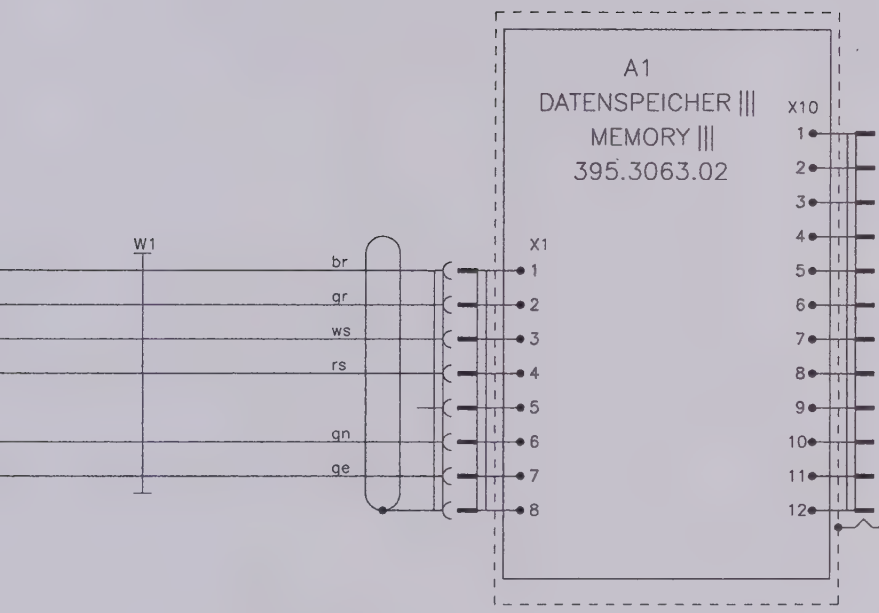
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								Gepr.		SR
Aend. Zust.	Aenderungsmitteilung	Datum	Name	Aend. Zust.	Aenderungsmitteilung	Datum	Name	Norm		

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3

4



PROBE	A1 MEMORY III			
	S1a	S1b	S2a	S2b
NRV-Z51	off	off	off	on

ACHTUNG: EGB !
ELEKTROSTATISCH GEFAEHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG.
ATTENTION ESD !
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING

VARIANTENERKLAERUNG/VERSIONS
VAR02 = GRUNDAUSFUEHRUNG
MOD02 = BASIC MODEL

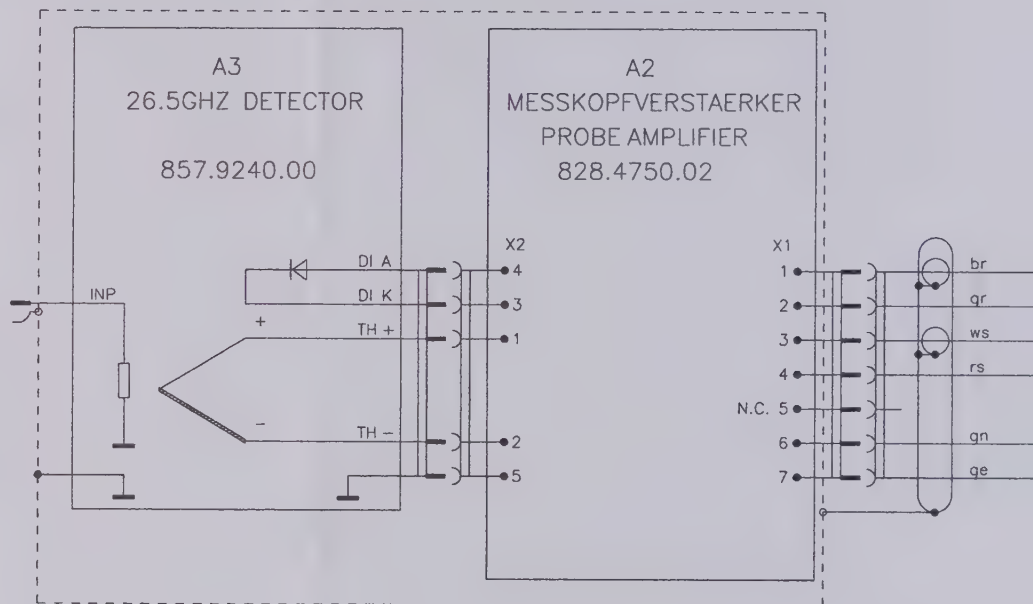
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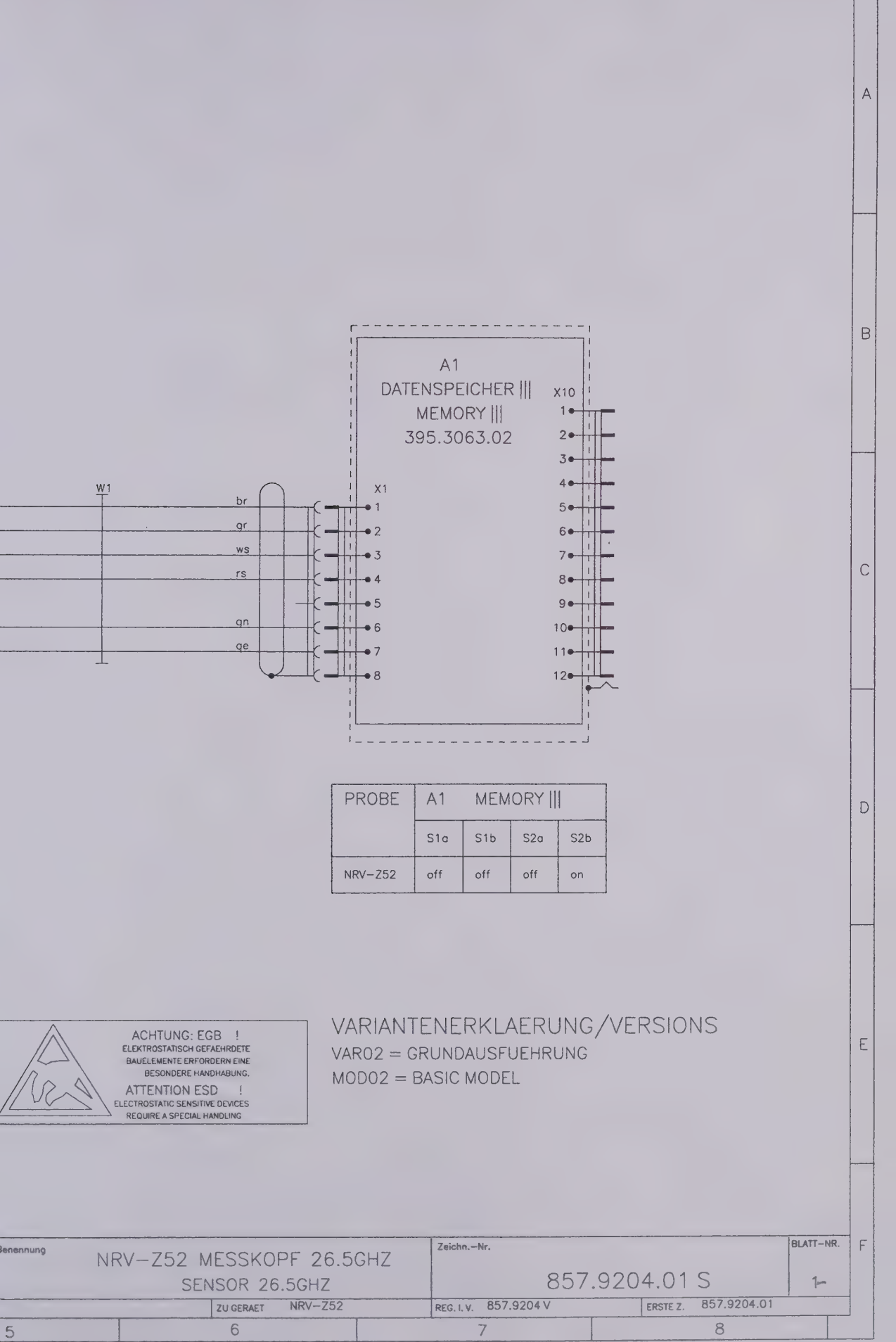
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FUER DIESE UNTERLAGE
BEHALTEN WIR UNS ALLE RECHTE VOR



ROHDE & SCHWARZ

04								1GPK	Datum	Name
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								Gepr.		SR
Aend. Zust.	Aenderungsmitteilung	Datum	Name	Aend. Zust.	Aenderungsmitteilung	Datum	Name	Norm		



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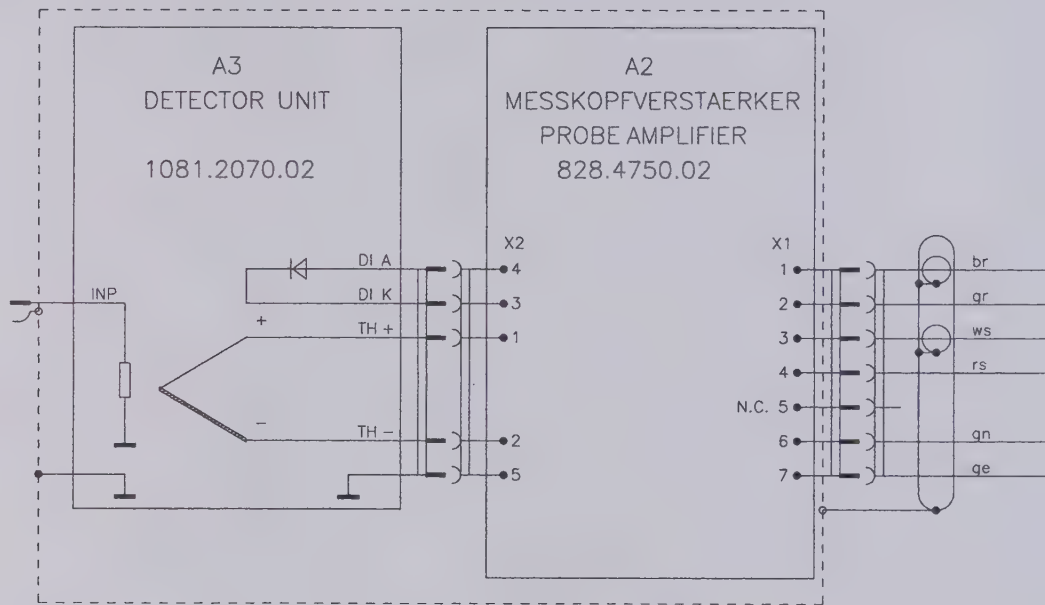
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C

D

E

F

FÜR DIESE UNTERLAGE
BEHALTEN WIR UNS ALLE RECHTE VOR

ROHDE & SCHWARZ

01								1GPK	Datum	Name
								Bearb.	26.11.96	SR
								Gepr.		SR
Aend. Zust.	Aenderungsmitteilung	Datum	Name	Aend. Zust.	Aenderungsmitteilung	Datum	Name	Norm		

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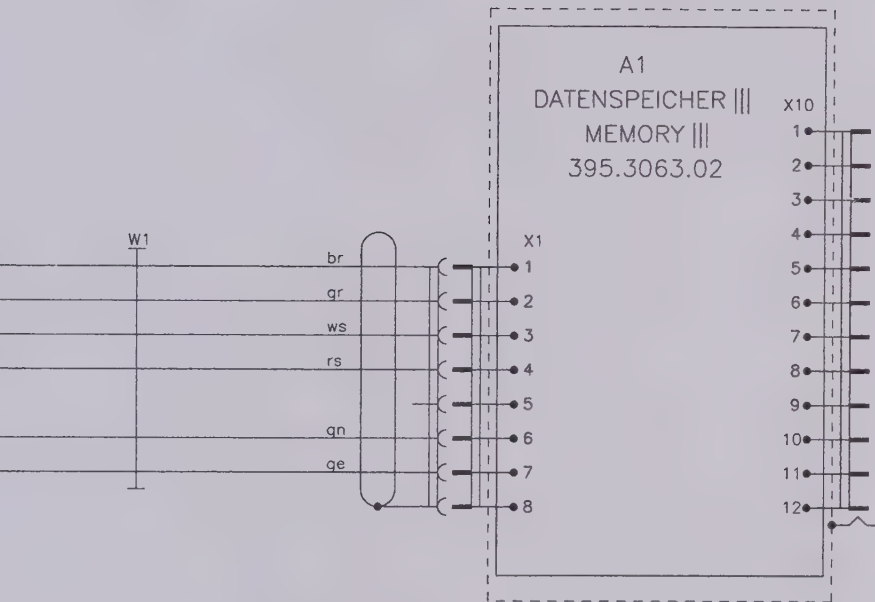
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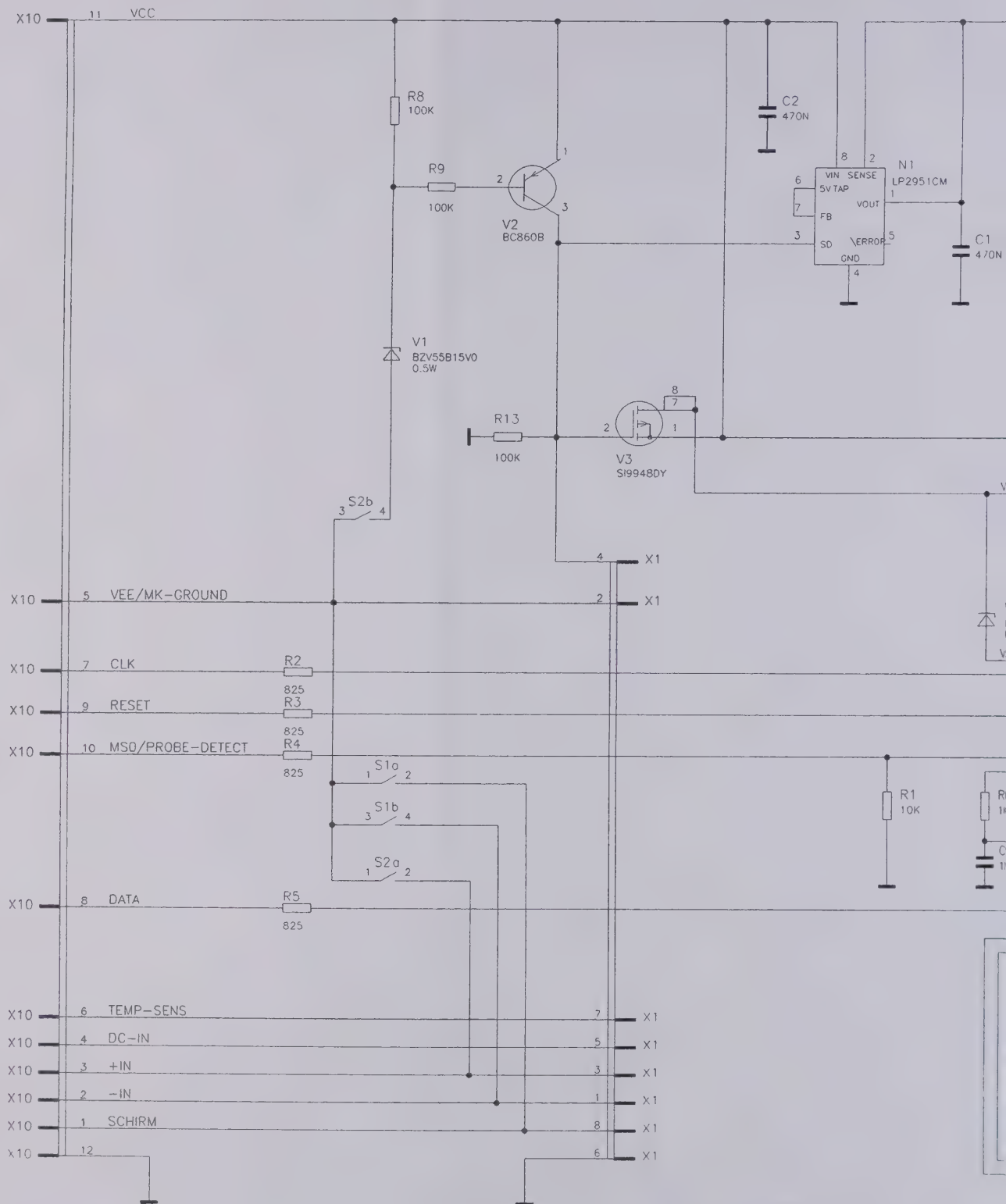
PROBE	A1 MEMORY			
	S1a	S1b	S2a	S2b
NRV-Z55	off	off	off	on

5

6

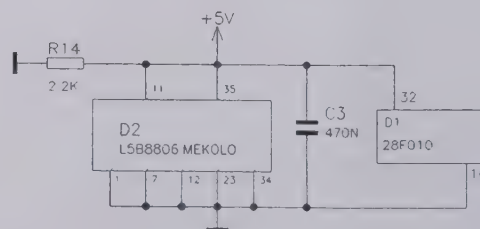
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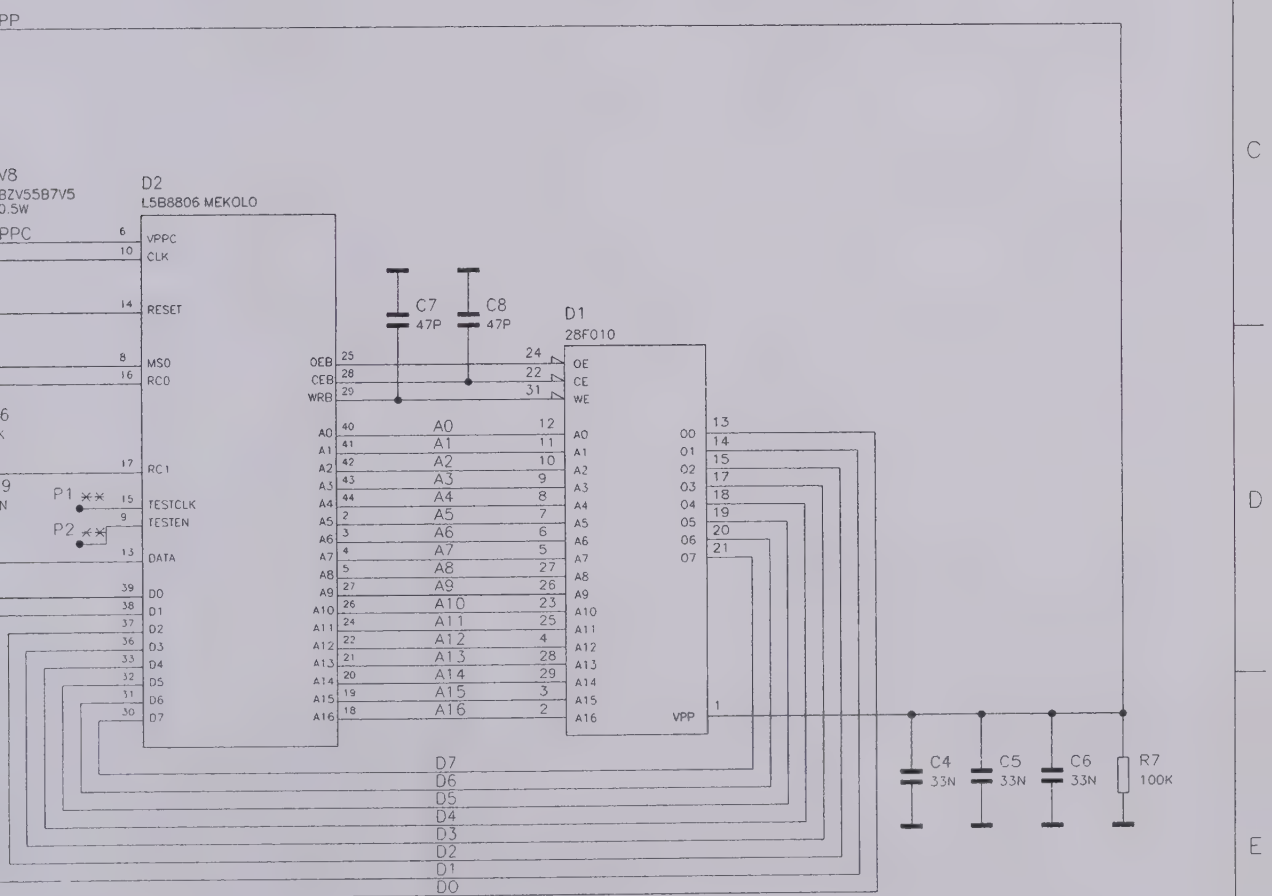
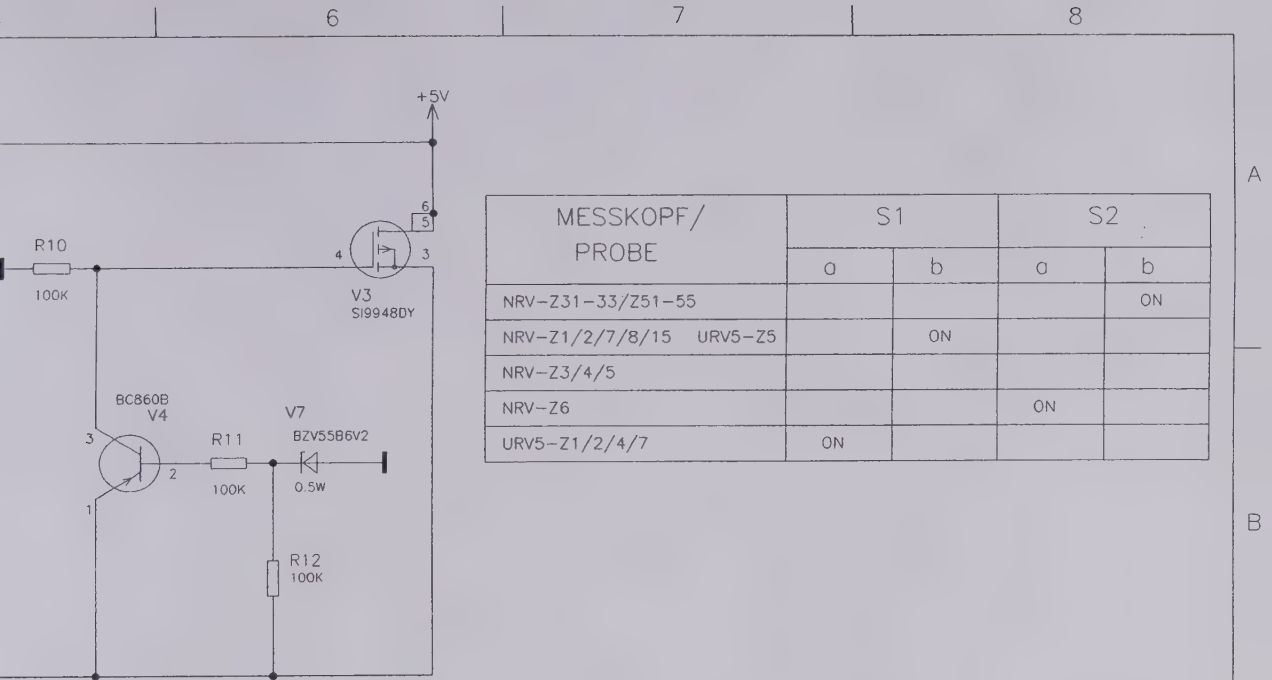


** = NOT FITTED

Bindende Angaben ueber Varianten,
Trimmwerte, Bauteile und
nicht bestueckte Bauteile siehe SA
FOR BINDING INFORMATION ON MODELS,
TRIMMING AND COMPONENTS VALUES AND
NONFITTED COMPONENTS SEE PARTS LIST



ACHTUNG: EGB !
ELEKTROSTATISCH GEFAEHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG
ATTENTION ESD !
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING



		BU	1GPK	DATUM	NAME	BENENNUNG	
			BEARB		SR	DATENSPEICHER_III	
			GEPR.			MEMORY_III	
			NORM			TOP/TOP.1	
			PLOTT	14.11.96	SR	ZEICHN.-NR.	
			ROHDE&SCHWARZ			395.3063.01 S	
						BLATT-NR.	
						1 -	
						v BL	
AENDERUNGS-MITTEILUNG	DATUM	NAME	ZU GERAET	URV5-Z7	REG.I.V.	395.2615	ERSTE Z. 000.0000

FUER DIESE UNTERLAGE
BEHALTEN WIR UNS ALLE RECHTE VOR

X2 4
DI A

X2 3
DI K

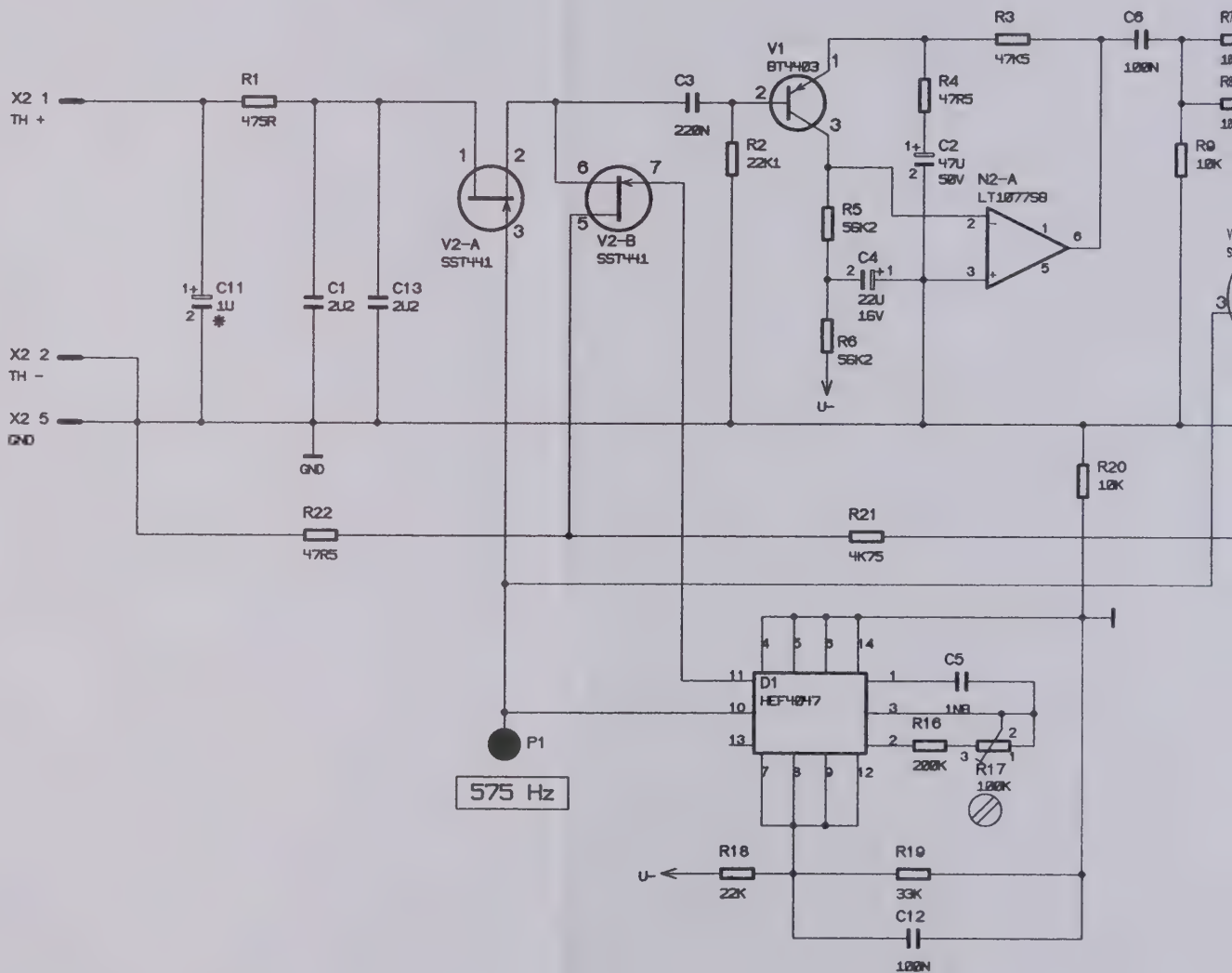
X2 1
TH +

X2 2
TH -

X2 5
GND

P1

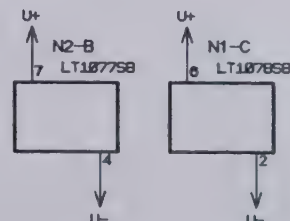
R17



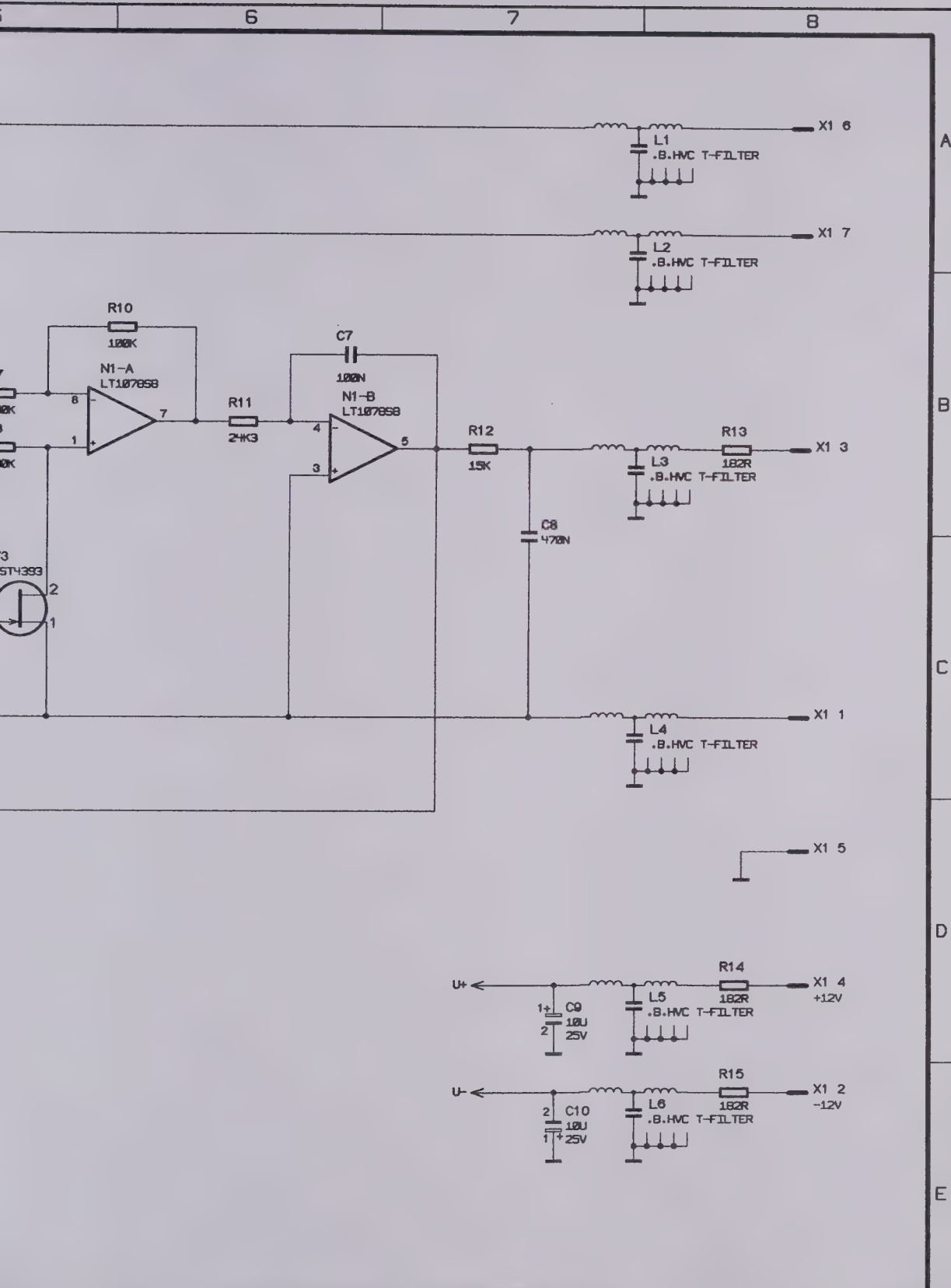
* NICHT BESTUECKT
NOT FITTED



ACHTUNG: EGBI
ELEKTROSTATISCH GEFÄHRDETE
BAUELEMENTE ERFORDBEN EINE
BESONDERE HANDHABUNG.
ATTENTION ESD!
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING



01
AEND.
IND.



			1GPK	TAG	NAME	BENENNUNG		sheet0	
			BEARB.		BU	MESSKOPFVERSTÄRKER PROBE AMPLIFIER		BLATT-NR. 1	
			GEPR.		BU				
			NORM						
			PLOTT	08.06.94		top		V. 1	
			R/S			ZEICHN.-NR.		828.4750.01S	
			ROHDE&SCHWARZ					V. 1 BL.	
			ZU GERÄT NRV-Z51			REG.I.V. 857.9004		ERSTE Z.	
ÄNDERUNGS- MITTEILUNG		DATUM	NAME						
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DARSTELLUNG SEITE B
VIEW ON SIDE B

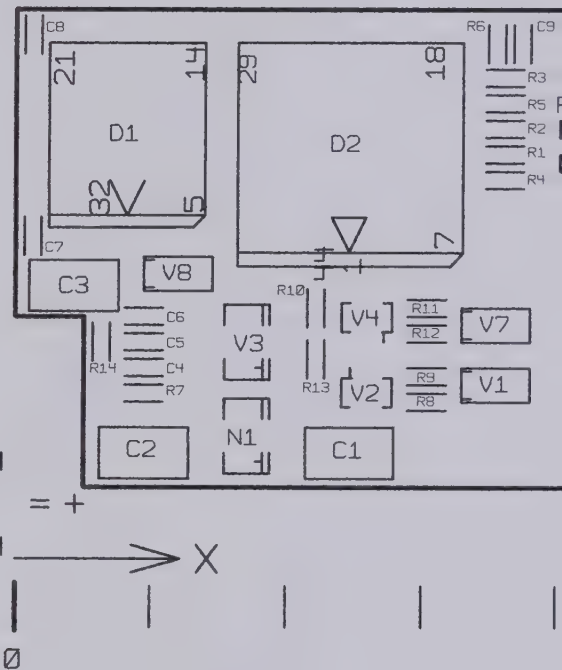


ACHTUNG: EGB!
ELEKTROSTATISCH GEFÄHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG.

ATTENTION ESD!
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING

BINDENDE ANGABEN UEBER VARIANTEN,
TRIMMWERTE, BAUTEILWERTE UND
NICHT BESTUECKTE BAUTEILE SIEHE SA.

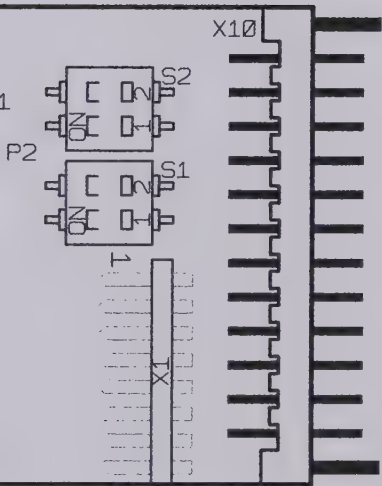
FOR BINDING INFORMATION ON MODELS,
TRIMMING AND COMPONENTS VALUES AND
NONFITTED COMPONENTS SEE PARTS LIST.



03

02

AEND.
IND.



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			1GPK	DATUM	NAME	BENENNUNG		
			BEARB.		SR	DATENSPEICHER_III MEMORY_III		
			GEPR.		SR			
			NORM					
			PLOTT	14.11.96	BAUR_A			
			ROHDE&SCHWARZ			ZEICHN.-NR.		BLATT-NR.
						395,3063,01 D		1+
ÄNDERUNGS- MITTEILUNG	DATUM	NAME				V.		Bl.
			ZU GERAET URV5-Z7			REG.I.v. 395.2615		ERSTE Z. 000.0000

R25 V 0 8

DARSTELLUNG SEITE B
VIEW ON SIDE B

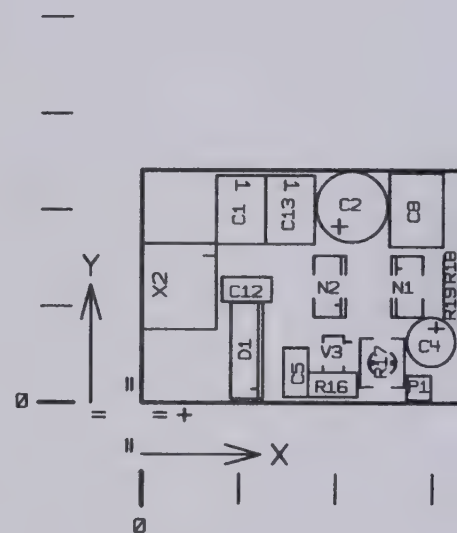


ACHTUNG: EGBI
ELEKTROSTATISCH GEFÄHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG.

ATTENTION ESD!
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING

BINDENDE ANGABEN UEBER VARIANTEN,
TRIMMWERTE, BAUTEILWERTE UND
NICHT BESTUECKTE BAUTEILE STEHE SA.

FOR BINDING INFORMATION ON MODELS,
TRIMMING AND COMPONENTS VALUES AND
NONFITTED COMPONENTS SEE PARTS LIST.



8

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	X1	L6	R15
	R14	R13	

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				1GPK	TAG	NAME	BENENNUNG		
				BEARB.		BU	MESSKOPFVERSTÄRKER PROBE AMPLIFIER		
				GEPR.		BU			
				NORM					
				PLOTT	09.02.94				
				 ROHDE & SCHWARZ				ZEICHN.-NR.	BLATT-NR.
								828.4750.01	ED
ÄNDERUNGS- MITTEILUNG	DATUM	NAME	ZU GERÄT NR-VZ51			REG.I.V. 857.9004	ERSTE Z.	V.	BL.

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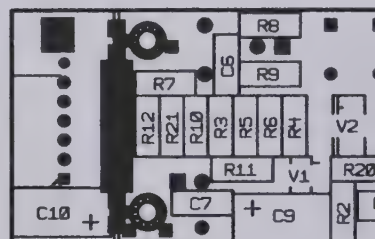
DARSTELLUNG SEITE A
VIEW ON SIDE A



ACHTUNG: EGBI
ELEKTROSTATISCH GEFÄHRDETE
BAUELEMENTE ERFORDERN EINE
BESONDERE HANDHABUNG.
ATTENTION ESD!
ELECTROSTATIC SENSITIVE DEVICES
REQUIRE A SPECIAL HANDLING

BINDENDE ANGABEN ÜBER VARIANTEN,
TRIMMWERTE, BAUTEILWERTE UND
NICHT BESTÜCKTE BAUTEILE SIEHE SA.

FOR BINDING INFORMATION ON MODELS,
TRIMMING AND COMPONENTS VALUES AND
NONFITTED COMPONENTS SEE PARTS LIST.



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FÜR DIESE UNTERLAGE
BEHALTEN WIR UNS ALLE RECHTE VOR

RS V1 a

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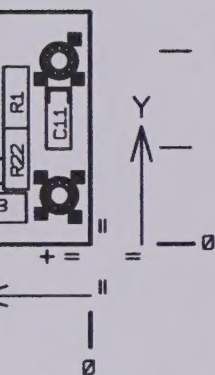
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				1GPK	TAG	NAME	BENENNUNG			
				BEARB.		BU	MESSKOPFVERSTÄRKER			
				GEPR.		BU	PROBE AMPLIFIER			
				NORM						
				PLOTT	09.02.94					
				RS ROHDE & SCHWARZ			ZEICHN.-NR.		BLATT-NR.	
							828.4750.01		ED	
ÄNDERUNGS- MITTEILUNG	DATUM	NAME		ZU GERÄT NRW-Z51			REG.I.V. 857.9004		ERSTE Z.	
									V.	BL.



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